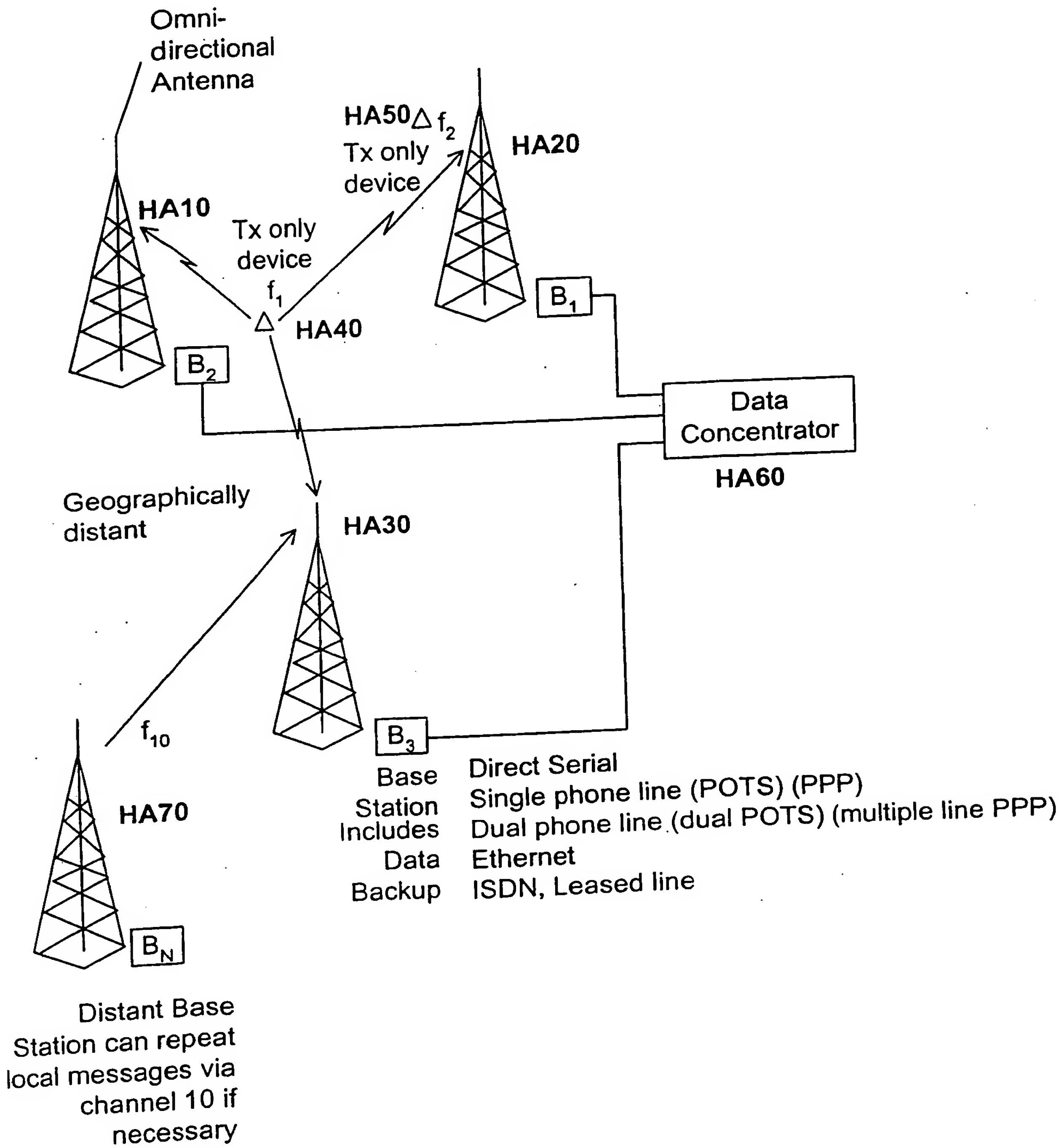
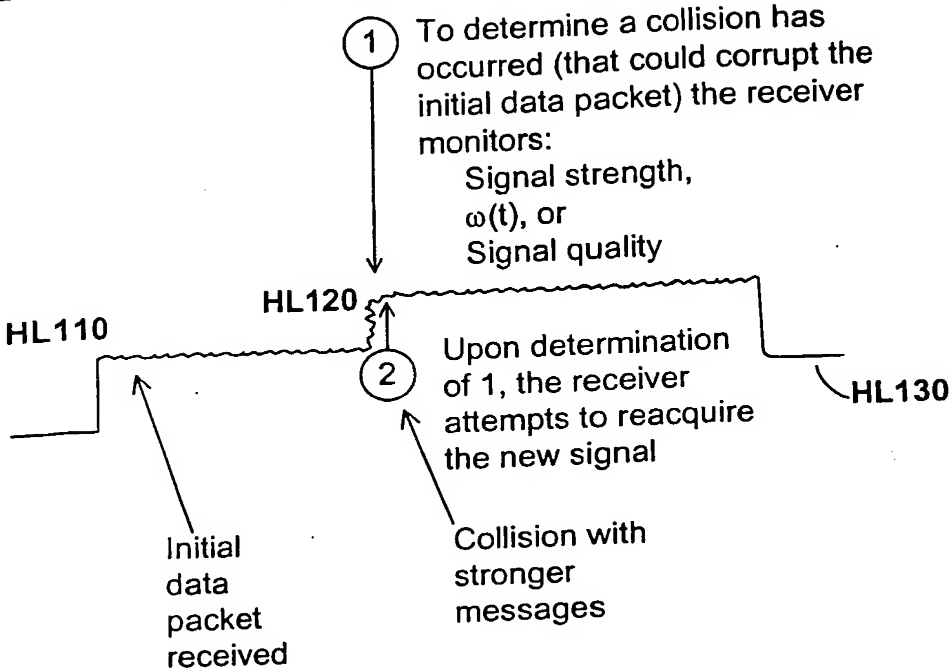
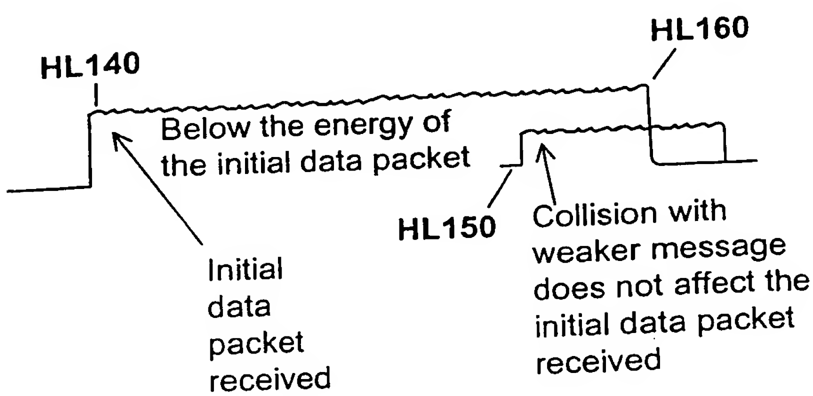

Omni-
directional
Antenna
HA50
f_2
Tx only
device
HA20
HA10
Tx only
device
f_1
HA40
B_1
B_2
Data
Concentrator
HA60
Geographically
distant
HA30
f_{10}
B_3
HA70
Base
Station
Includes
Data
Backup
Direct Serial
Single phone line (POTS) (PPP)
Dual phone line (dual POTS) (multiple line PPP)
Ethernet
ISDN, Leased line
B_N
Distant Base
Station can repeat
local messages via
channel 10 if
necessary

FIGURE 1

CASE I Initial Message Weaker than the Second



CASE II Initial Message Stronger than the Second



This method typically prevents the loss of both colliding data packets and therefore, meets the sloted ALOHA form (there is no "2" in the exponent)

Slotted ALOHA: $e^{-\lambda NT}$ Non-slotted ALOHA: $e^{-2\lambda NT}$

FIGURE 2

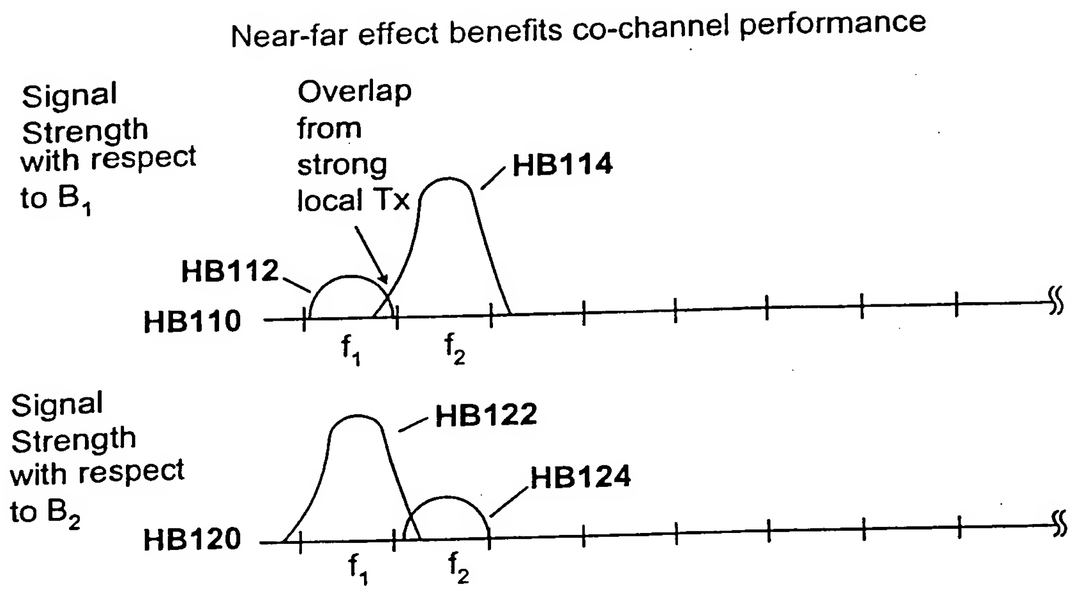

Near-far effect benefits co-channel performance
Signal Strength with respect to B_1
Overlap from strong local Tx
HB114
HB112
HB110
f_1
f_2
Signal Strength with respect to B_2
HB122
HB124
HB120
f_1
f_2

FIGURE 3

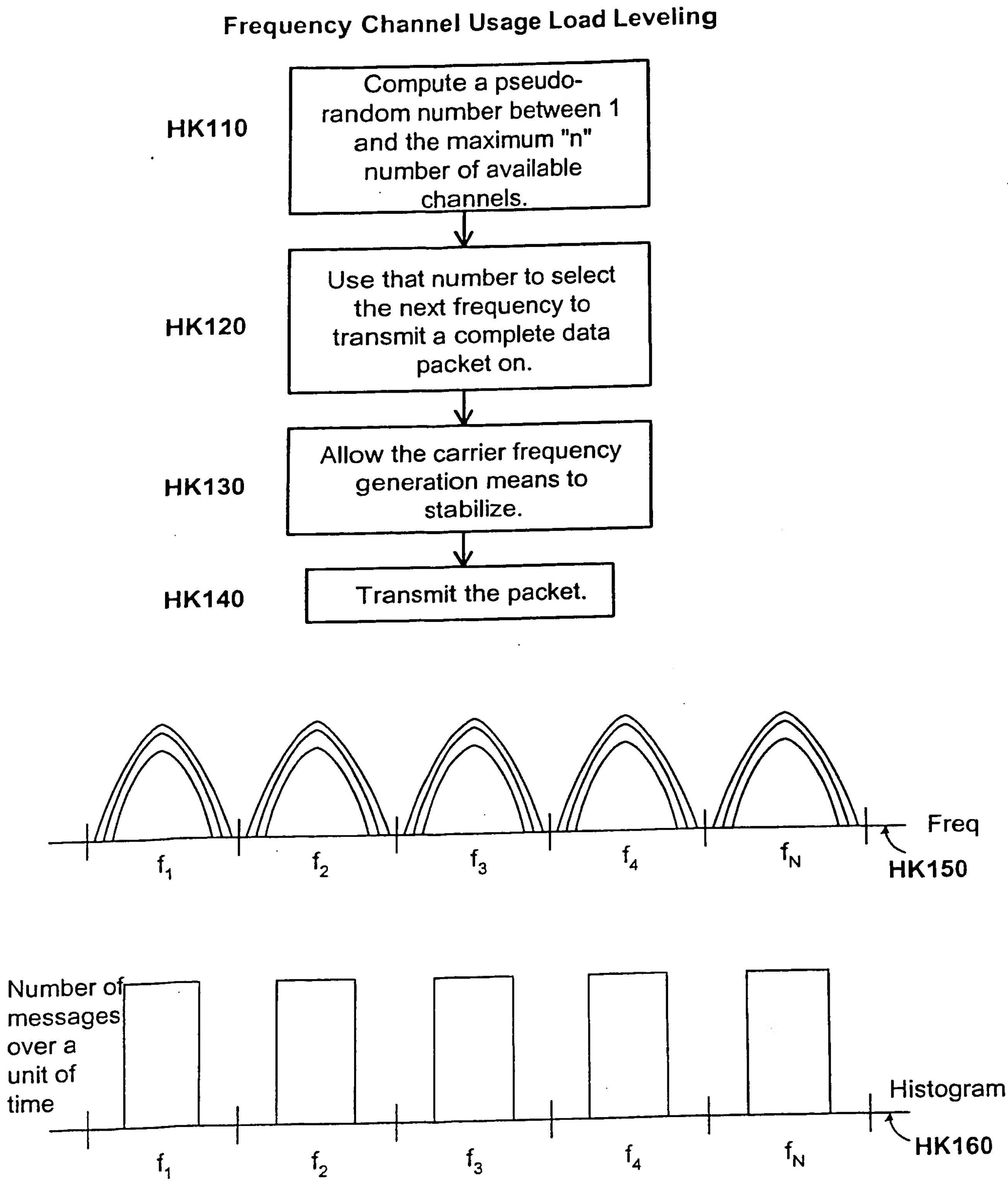
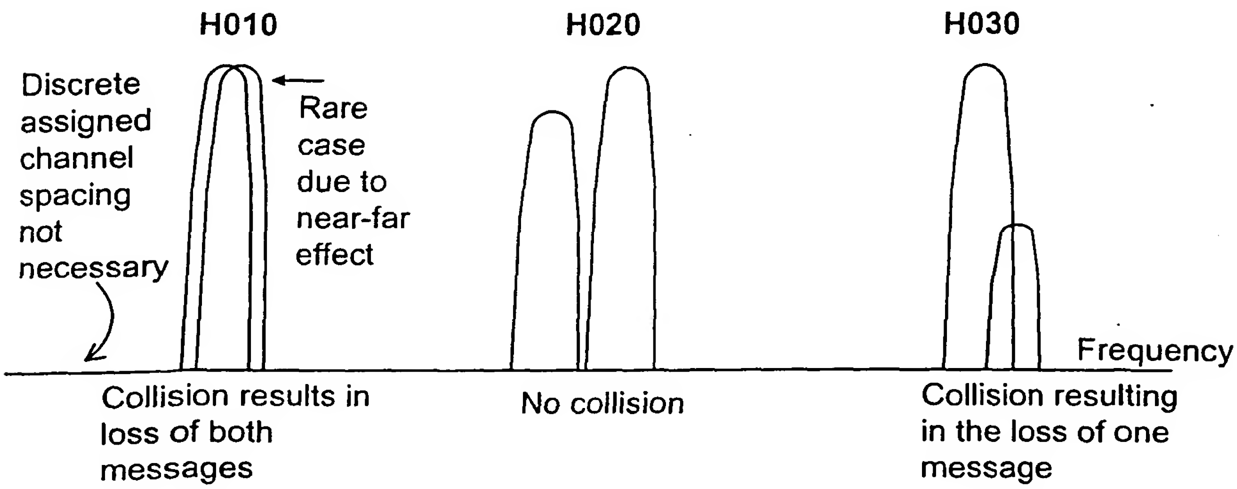

Frequency Channel Usage Load Leveling
HK110
Compute a pseudo-random number between 1 and the maximum "n" number of available channels.
HK120
Use that number to select the next frequency to transmit a complete data packet on.
HK130
Allow the carrier frequency generation means to stabilize.
HK140
Transmit the packet.
f_1
f_2
f_3
f_4
f_N
Freq
HK150
Number of messages over a unit of time
Histogram
HK160

FIGURE 4

Bandwidth Efficient, Non-channelized Spectrum Utilization



This method creates additional channel capacity

1) Utilizing channel spacing smaller than signal BW & guard band
2) Vary the transmitted frequency of transmissions so that channel overlap causes a statistical loss that is overcome by redundant transmissions and follows the form:

$$P_S = 1 - [1 - e^{-(2\lambda NT/P)}]^M$$

Assumes that a data collision in a channel causes loss of both messages where:

P_S = Probability of successful reception of "B" base stations
λ = 1/time between transmissions
N = Number of remote end-points in the coverage range of a base station - one
T = Time duration of a data packet
M = Number of times that a transmission is redundantly transmitted by a given end-point
P = Signal BW/available system BW

FIGURE 5

Conventional cellular system area coverage
Dots representing base stations
Coverage is designed to minimize overlap with adjacent cells

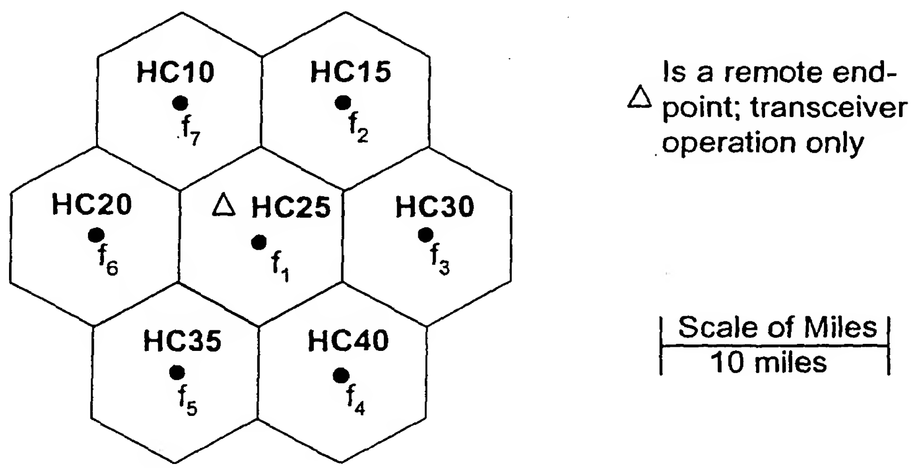
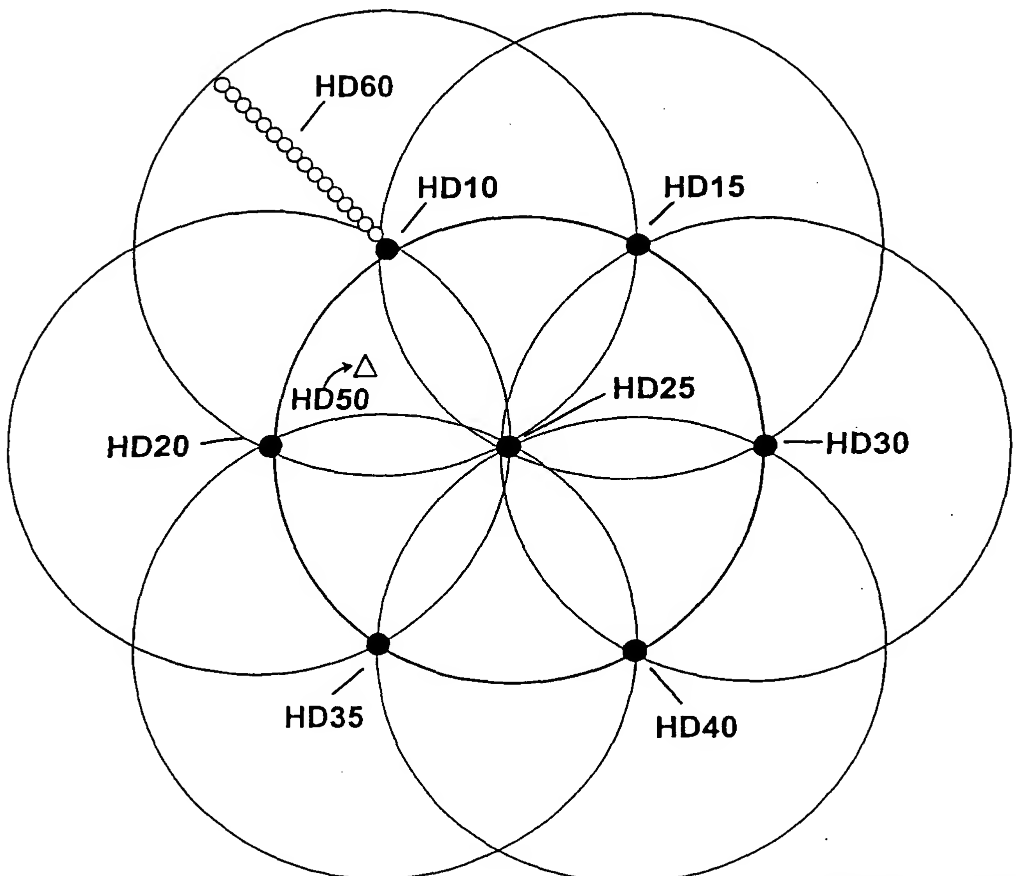


FIGURE 6
PRIOR ART

Cellular layout of instant invention
Coverage intentionally overlaps with adjacent cells
Creating significant signal redundancy

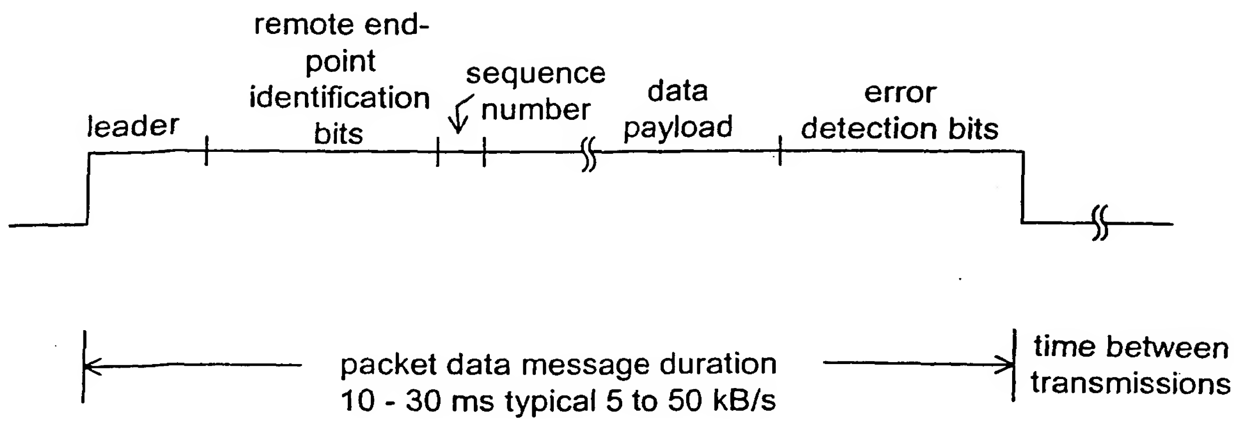


All operating on f_1

Scale of Miles
10 miles

△ Is a remote end-point;
transmit-only or
transceiver operation

FIGURE 7



data payload portion can contain a history of past readings:
present reading, Δ_1 from last reading, Δ_2 from Δ_1,..., Δ_{N+1} from Δ_N

FIGURE 8

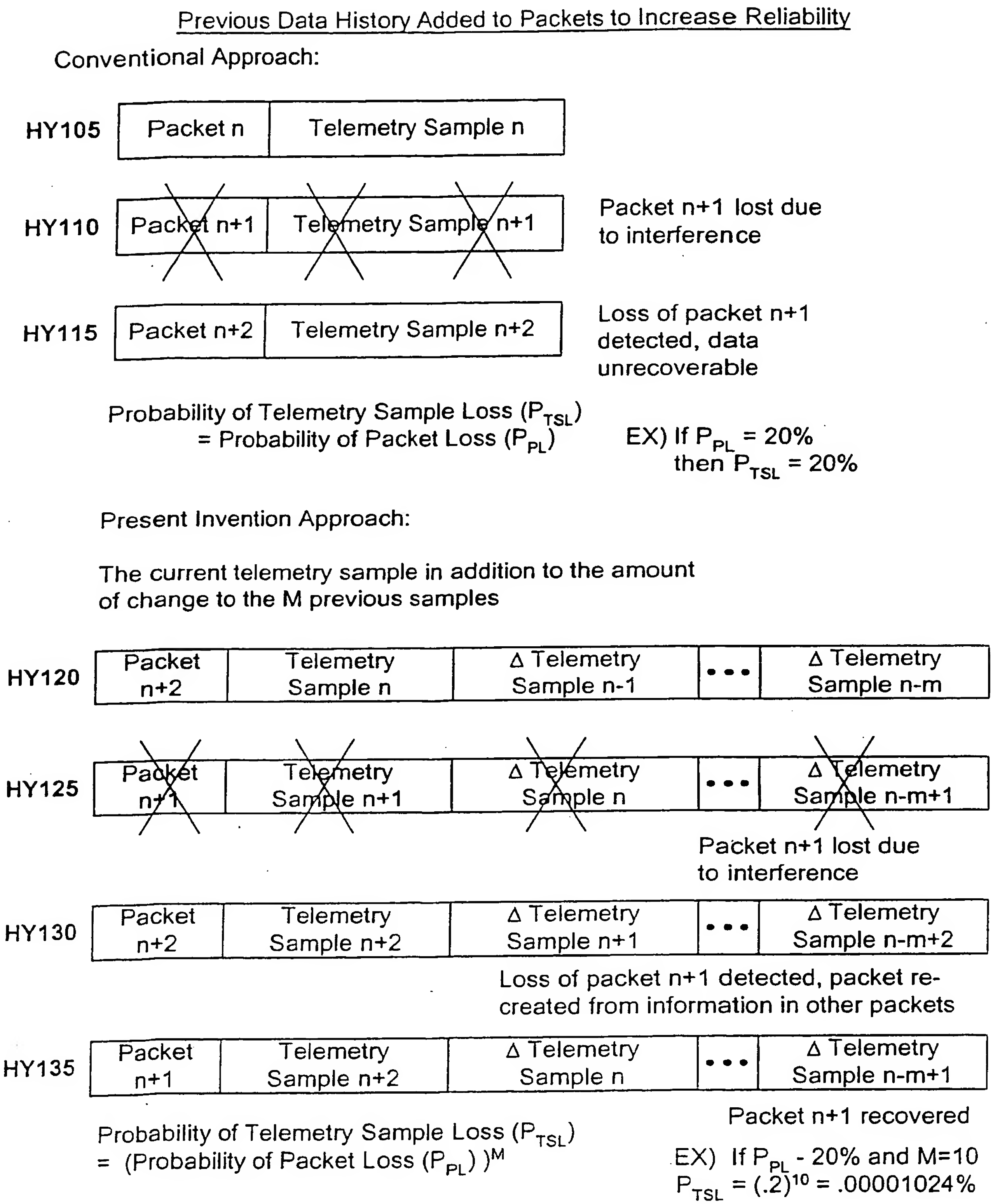

Previous Data History Added to Packets to Increase Reliability
Conventional Approach:
HY105
Packet n
Telemetry Sample n
HY110
Packet n+1
Telemetry Sample n+1
Packet n+1 lost due to interference
HY115
Packet n+2
Telemetry Sample n+2
Loss of packet n+1 detected, data unrecoverable
Probability of Telemetry Sample Loss (P_{TSL}) = Probability of Packet Loss (P_{PL})
EX) If P_{PL} = 20% then P_{TSL} = 20%
Present Invention Approach:
The current telemetry sample in addition to the amount of change to the M previous samples
HY120
Packet n+2
Telemetry Sample n
Δ Telemetry Sample n-1
• • •
Δ Telemetry Sample n-m
HY125
Packet n+1
Telemetry Sample n+1
Δ Telemetry Sample n
• • •
Δ Telemetry Sample n-m+1
Packet n+1 lost due to interference
HY130
Packet n+2
Telemetry Sample n+2
Δ Telemetry Sample n+1
• • •
Δ Telemetry Sample n-m+2
Loss of packet n+1 detected, packet re-created from information in other packets
HY135
Packet n+1
Telemetry Sample n+2
Δ Telemetry Sample n
• • •
Δ Telemetry Sample n-m+1
Packet n+1 recovered
Probability of Telemetry Sample Loss (P_{TSL}) = (Probability of Packet Loss (P_{PL}))^M
EX) If P_{PL} - 20% and M=10
P_{TSL} = $(.2)^{10}$ = .00001024%

FIGURE 9

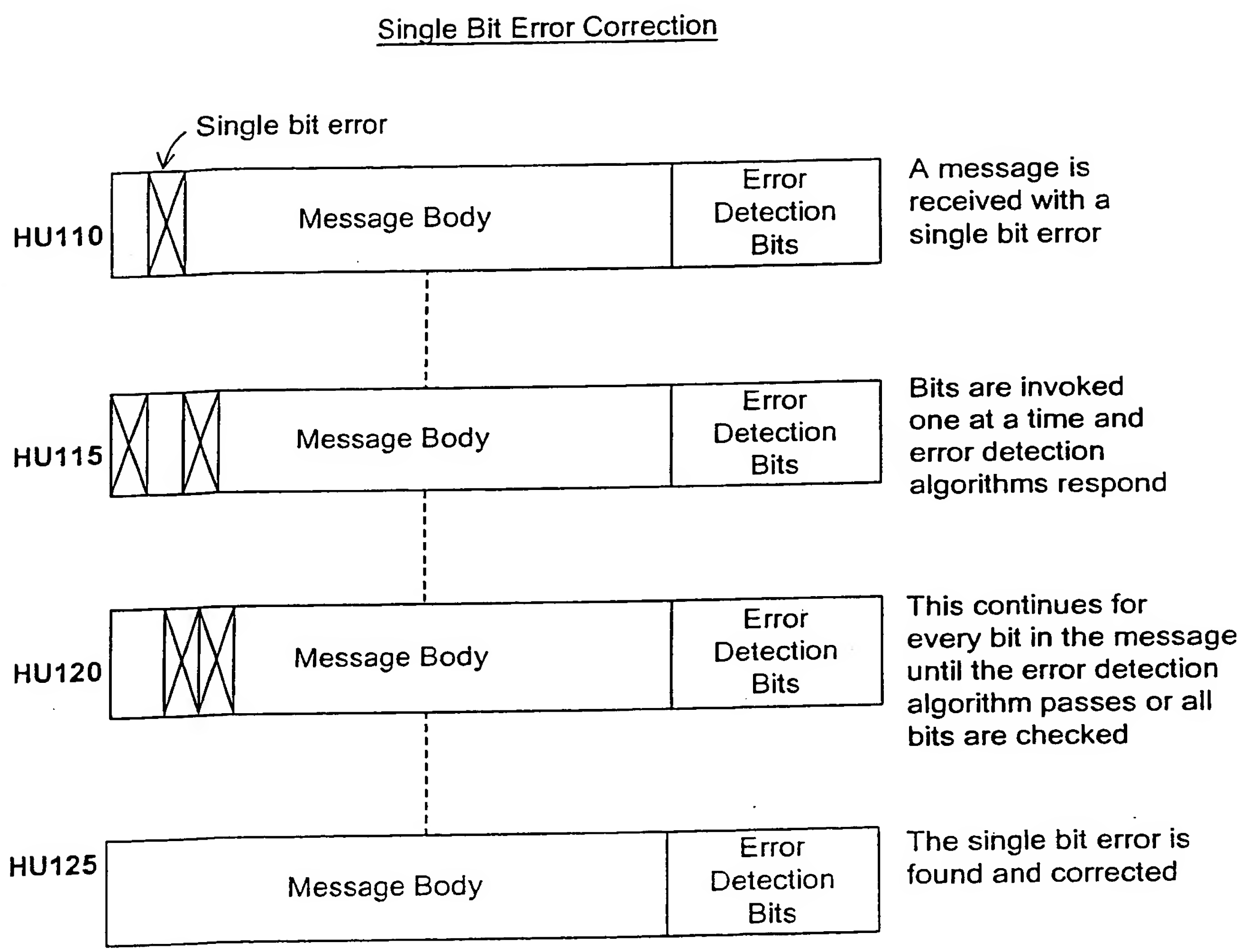

Single Bit Error Correction
Single bit error
HU110
Message Body
Error Detection Bits
A message is received with a single bit error
HU115
Message Body
Error Detection Bits
Bits are invoked one at a time and error detection algorithms respond
HU120
Message Body
Error Detection Bits
This continues for every bit in the message until the error detection algorithm passes or all bits are checked
HU125
Message Body
Error Detection Bits
The single bit error is found and corrected

FIGURE 10

Message Sequence Numbers for Missed Message

				Detection and Security
HV110	Remote Endpoint #123456789	Sequence 3210	Message n	Sequence indicates that the next message should be 3211
HV115	Remote Endpoint #123456789	Sequence 3212	Message n + 1	Sequence indicates that message 3211 was missed and should be recreated
HV120	Remote Endpoint #123456789	Sequence 3213	Message n + 2	Normal expected sequence
HV125	Remote Endpoint #123456789	Sequence 1201	Message n + 3	Illegal message from invalid endpoint, sequence grossly in error. Security violation detected.
HV130	Remote Endpoint #123456789	Sequence 3214	Message n + 4	Normal expected sequence

FIGURE 11

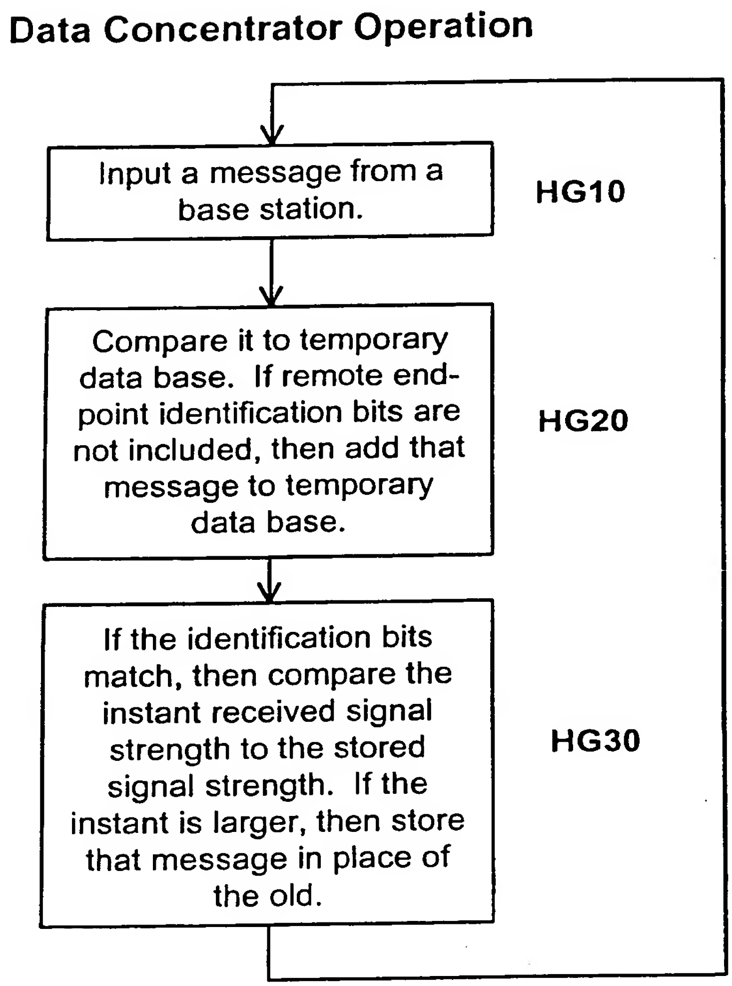
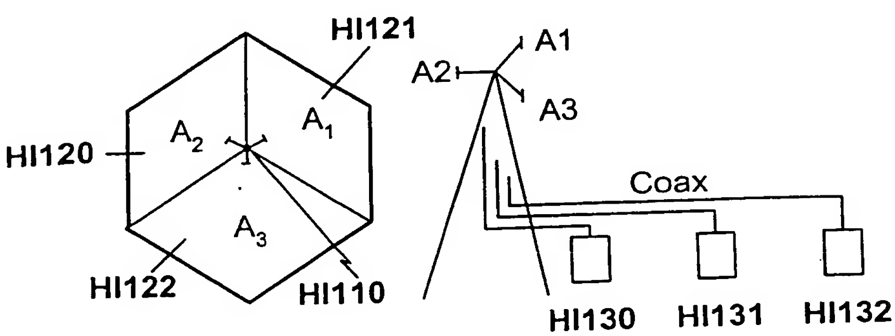

Data Concentrator Operation
Input a message from a base station.
HG10
Compare it to temporary data base. If remote end-point identification bits are not included, then add that message to temporary data base.
HG20
If the identification bits match, then compare the instant received signal strength to the stored signal strength. If the instant is larger, then store that message in place of the old.
HG30

FIGURE 12

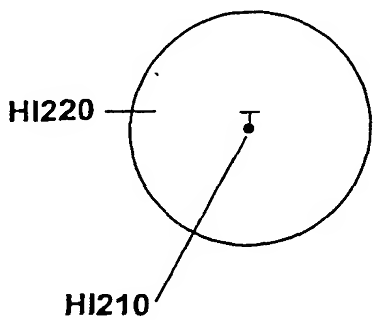
Conventional Cellular Radio Systems Utilize Sectored Antennas to Increase Capacity

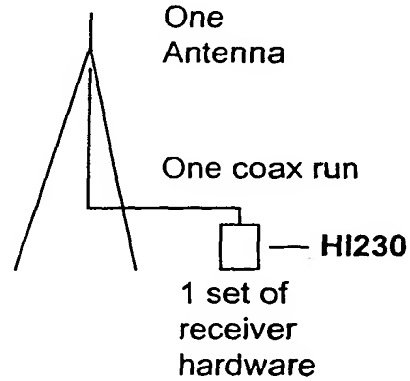


Requires 3 Sets of receiver hardware

FIGURE 13
PRIOR ART

The instant invention utilizes a single omni-directional antenna with overlapping coverage of adjacent cells to reduce cost and with the combined messages from adjacent cells to provide macro diversity and resistance to shading.

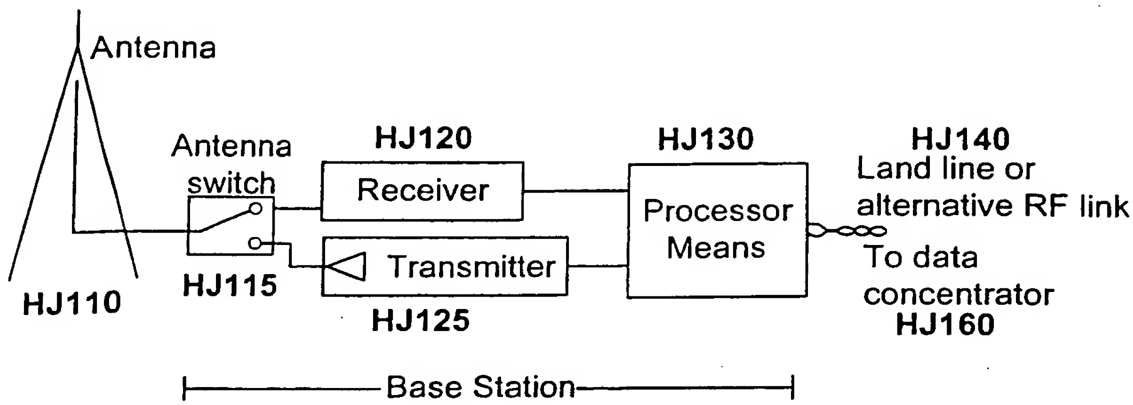




$$P_S = 1 - [1 - e^{-\lambda NT}]^{MB}$$

P_S = Probability of success of "B" base stations
λ = 1/time between transmissions
N = Number of remote end-points in the coverage range of a base station - one
T = Time duration of a data packet
M = Number of times that a transmission is redundantly transmitted by a given end-point
B = Number of base stations that are in radio range of the remote end-point

FIGURE 14



- Base station operates in half duplex mode to reduce cost. In full duplex mode, unless transmit and receive frequencies are widely spaced the base station transmission would de-sense its own receiver.

- Outbound transmissions to two-way remote end-points are limited to approximately a 1% duty cycle. The 1% is then added to the ALOHA channel capacity and has minimal system impact.

$$P_S = 1 - \left[1 - e^{-(\lambda NT + 1\%)}\right]^M$$

P_S = Probability of successful reception
λ = 1/time between transmissions
N = Number of remote end-points in the coverage range of a base station - one
T = Time duration of a data packet
M = Number of times that a transmission is redundantly transmitted by a given end-point

FIGURE 15

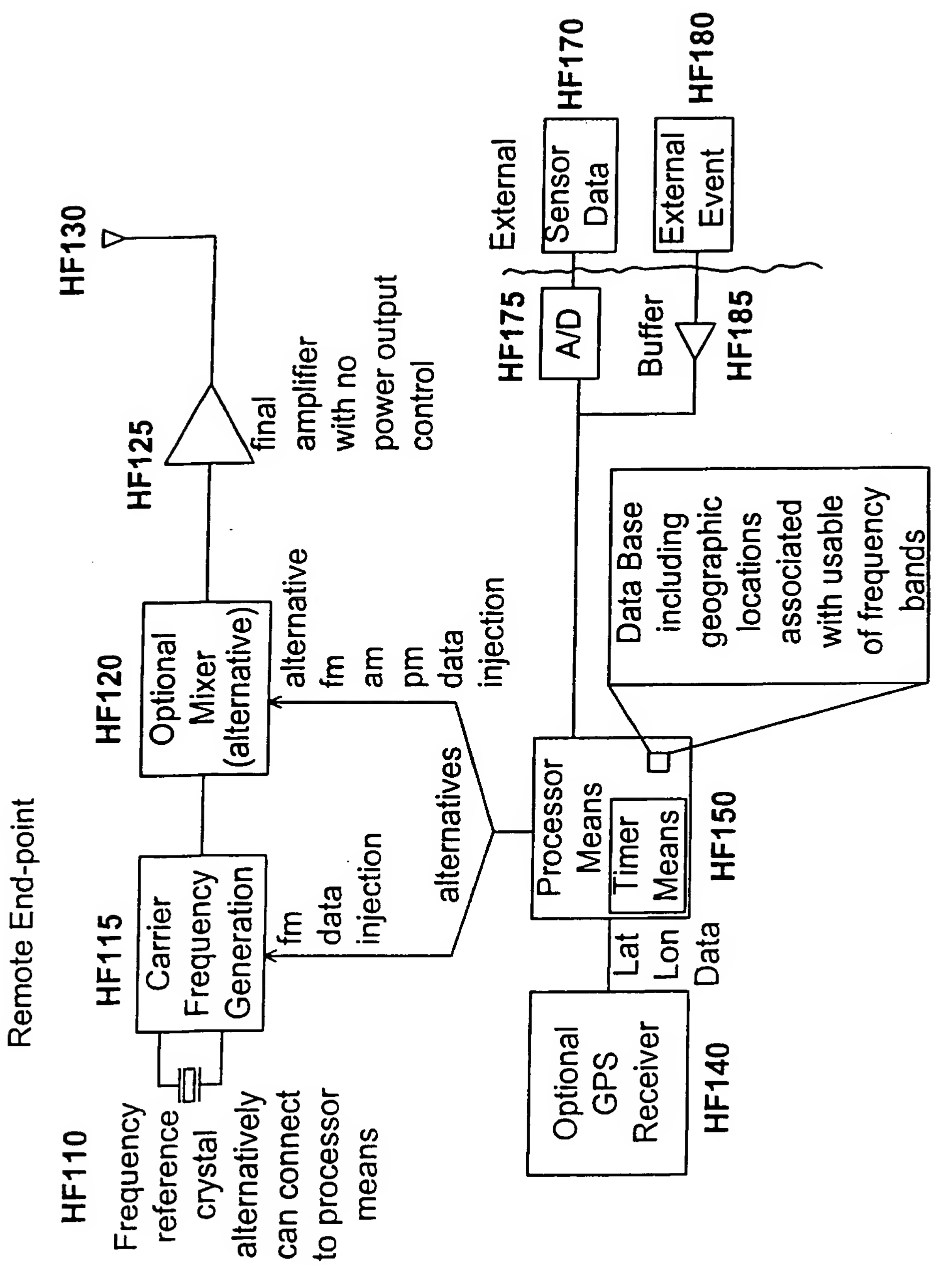

Remote End-point
HF110
Frequency reference crystal alternatively can connect to processor means
HF115
Carrier Frequency Generation
fm data injection
HF120
Optional Mixer (alternative)
alternative fm am pm data injection
alternatives
HF125
final amplifier with no power output control
HF130
HF140
Optional GPS Receiver
Lat Lon Data
HF150
Processor Means
Timer Means
HF160
Data Base including geographic locations associated with usable of frequency bands
HF175
A/D
Buffer
HF185
External
HF170
Sensor Data
HF180
External Event

FIGURE 16

Method to Allow Wide Geographic Freedom Over Different Licensed Frequency Bands in a Mobile Tracking System Without the Need of Externally Controlled Frequency Switch-over and Management

Read position fix from GPS receiver (or the like). HP10

↓

Use data base means to look up allowable frequency band of usage associated with geographic boundaries. HP20

↓

Transmit the GPS Lat/Lon data on the frequency band looked up from the data base. HP30

Data base contains boundaries and available frequency bands

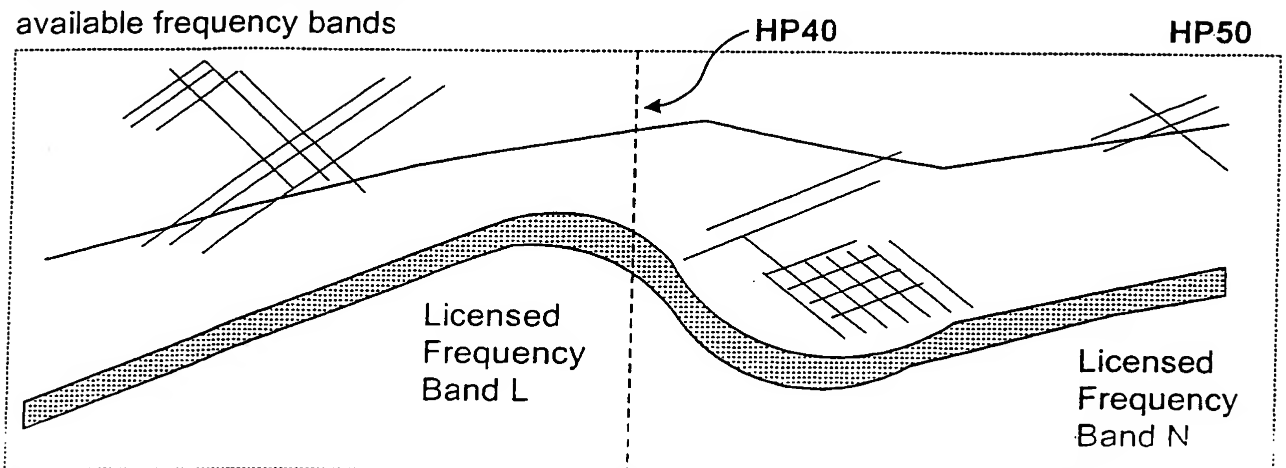
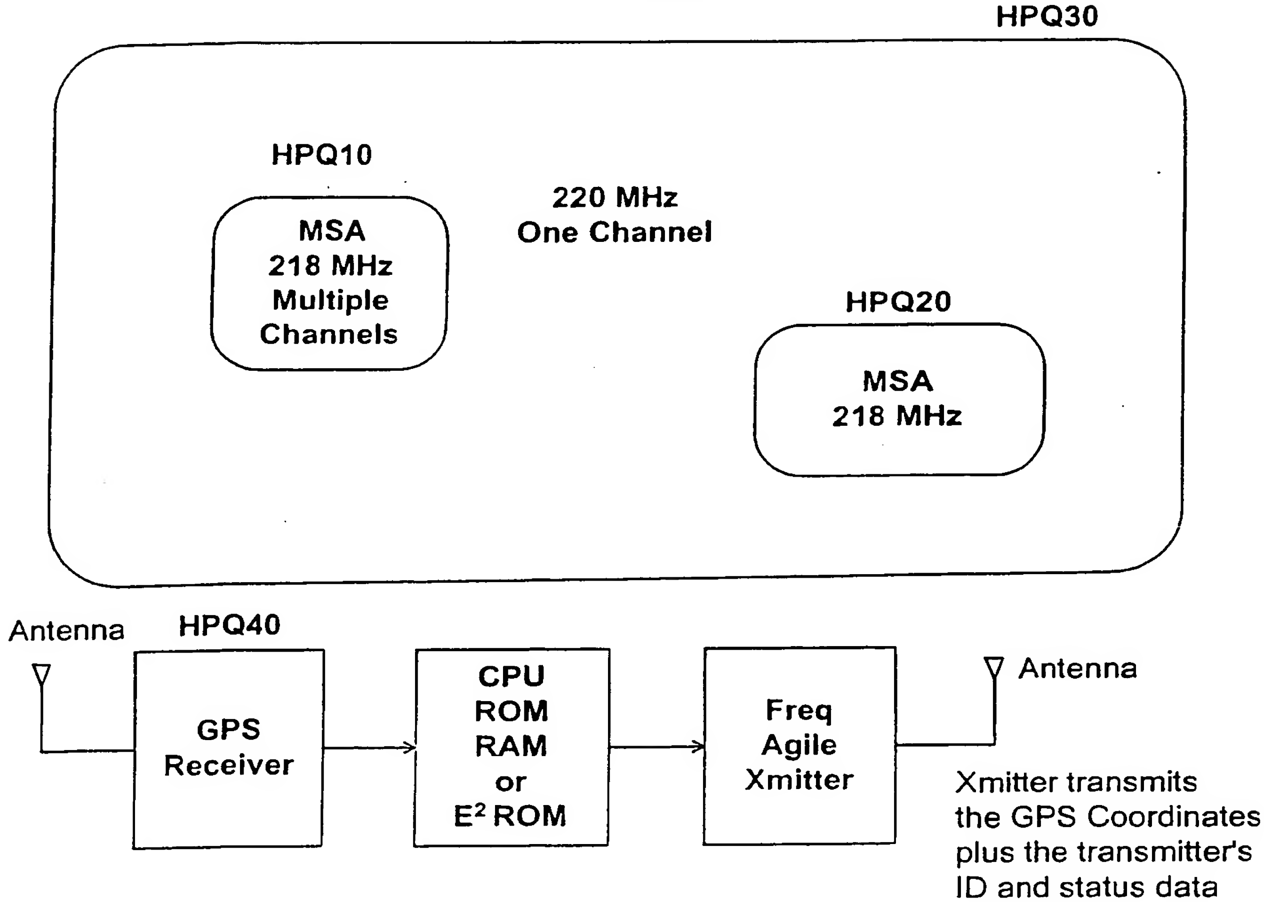


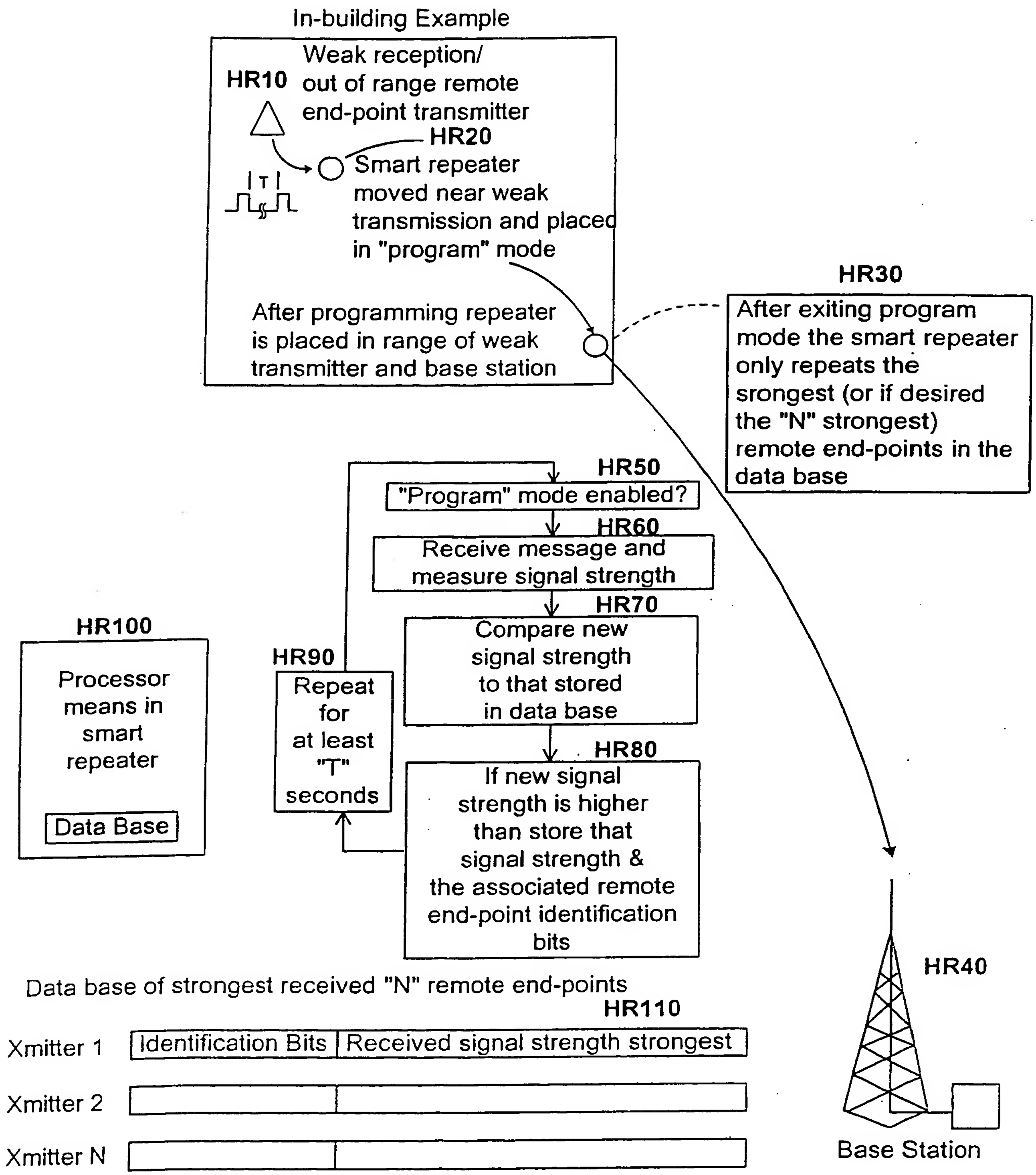
FIGURE 17

Example of Automatic Frequency Selection for Transmit-only System Sending GPS Data for Remote Location



CPU (μc) is loaded with MSA boundaries. The CPU reads coordinates from GPS receiver. The CPU determines if the coordinates are in the bounds of the MSA. If yes, the CPU sets the frequency agile transmitter to 218 MHz (one of several available channels); if no, the CPU sets the frequency agile transmitter to 220 MHz. In this method more message traffic can be supported with multiple MSA channels.

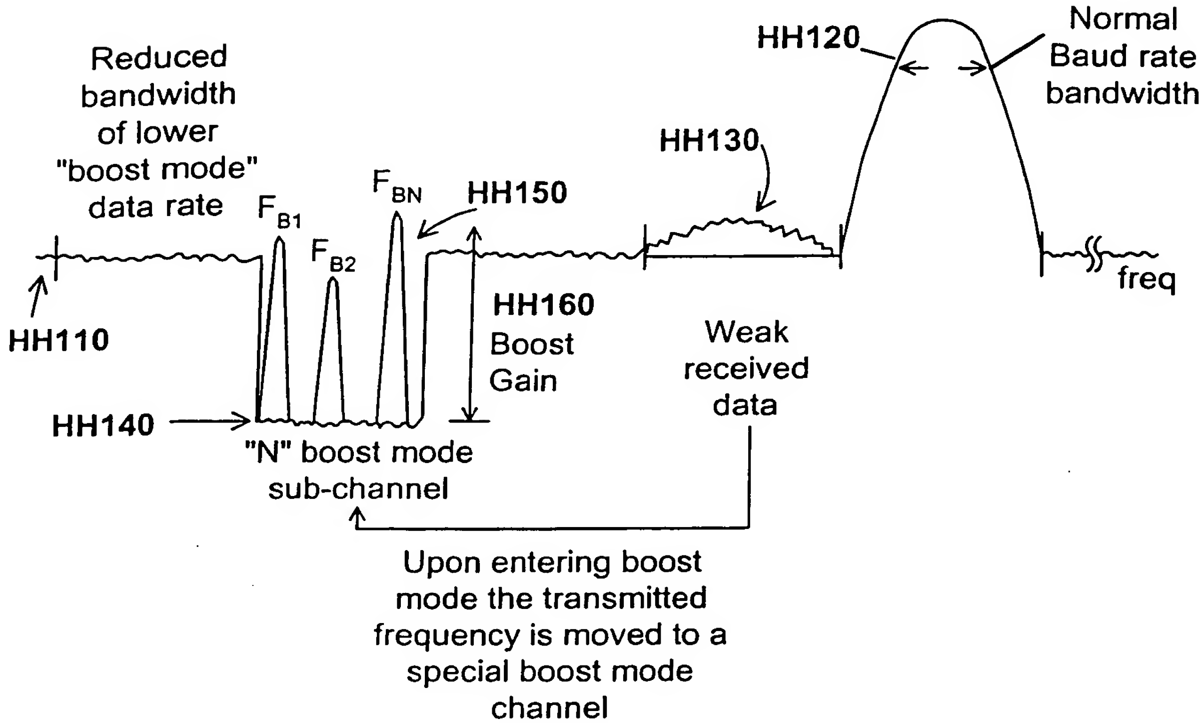
FIGURE 18



Alternatively, the smart repeater can be used in LAN applications. Additionally, the smart repeater may utilize narrow band modulation, frequency hopping or direct sequence spread spectrum.

FIGURE 19

Selectable Enhanced Signal Margin Without the Cost of Higher Output Power Transmitter Amplifier Stages



$$\text{SNR improvement} = 10 \log \frac{\text{Normal Baud Rate}}{\text{Lower (Boost) Baud Rate}}$$

$$10 \log \frac{16.64 \text{ kb/s}}{520 \text{ bps}}$$

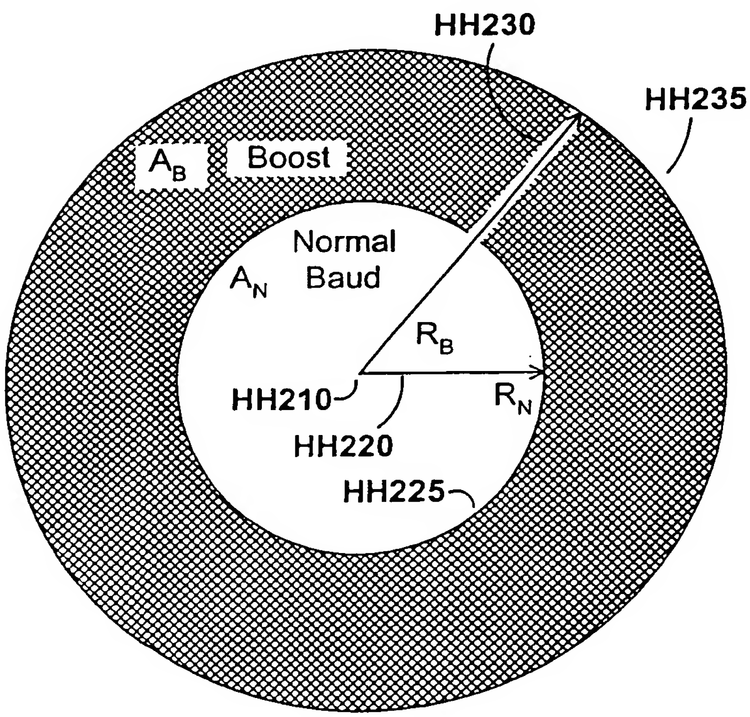
$$= 15 \text{ dB}$$

15dB boost mode can overcome the 10-15 dB loss from mounting a remote end-point in a buried water meter.

To match this signal margin improvement, the remote end-point transmitter would have to transmit 32 times more signal power.

FIGURE 20

Boost mode can significantly increase the service coverage area providing that the density of the transmitted packets can be significantly limited.



(Normal Area)
$\pi R^2 = A_N$

(Additional Boost Area)
$\pi R_B^2 - \pi R_N^2 = A_B$

IF R_N = 5 Miles

IF 15dB of boost mode signal enhancement doubles range to 10 miles, then:

$\pi\ (5+5)^2 - \pi\ (5)^2 = A_B$

$314 - 79$ mi $= A_B$

235 mi $= A_B$
additional area covered by boost mode

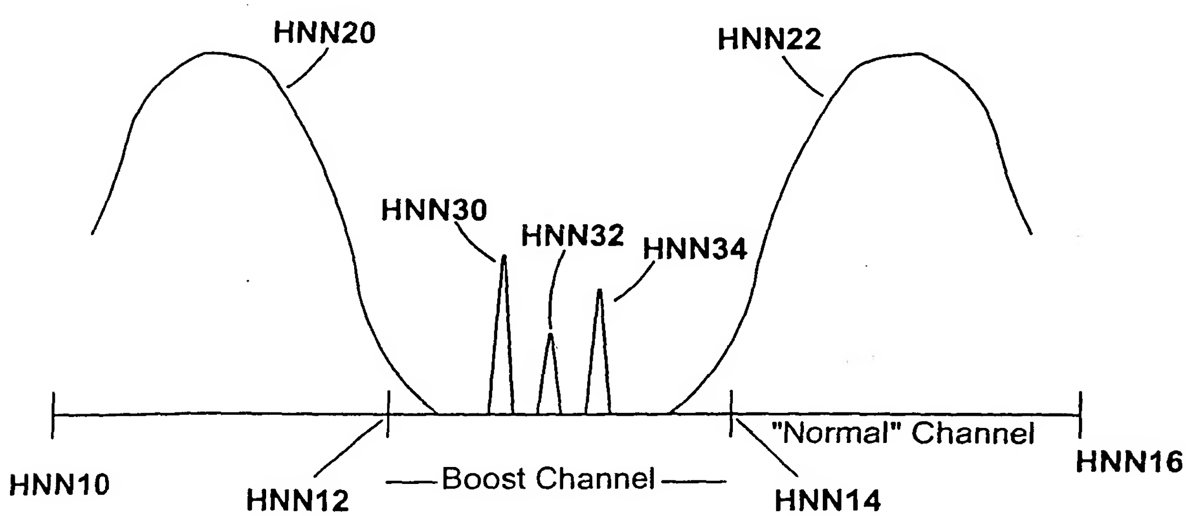
FIGURE 21

Boost Mode Channel Load Leveling

$$\text{Number transmitted packets reduced by} \propto \frac{\text{Normal Baud}}{\text{Lower ("Boost") Baud}}$$

FIGURE 22

Separate Boost Channel is Assigned to Avoid the Channel Roll Off of Strong Transmitters Adjacent Channels



The boost sub-channels are concentrated in the middle of the channel assigned to receive boost mode transmission.

Bleed-over from adjacent channels can be caused by frequency drift, osicllator phase noise, PLL spurs, modulation roll off, transmitter data filter roll-off, crystal aging or Dopler shift.

FIGURE 23

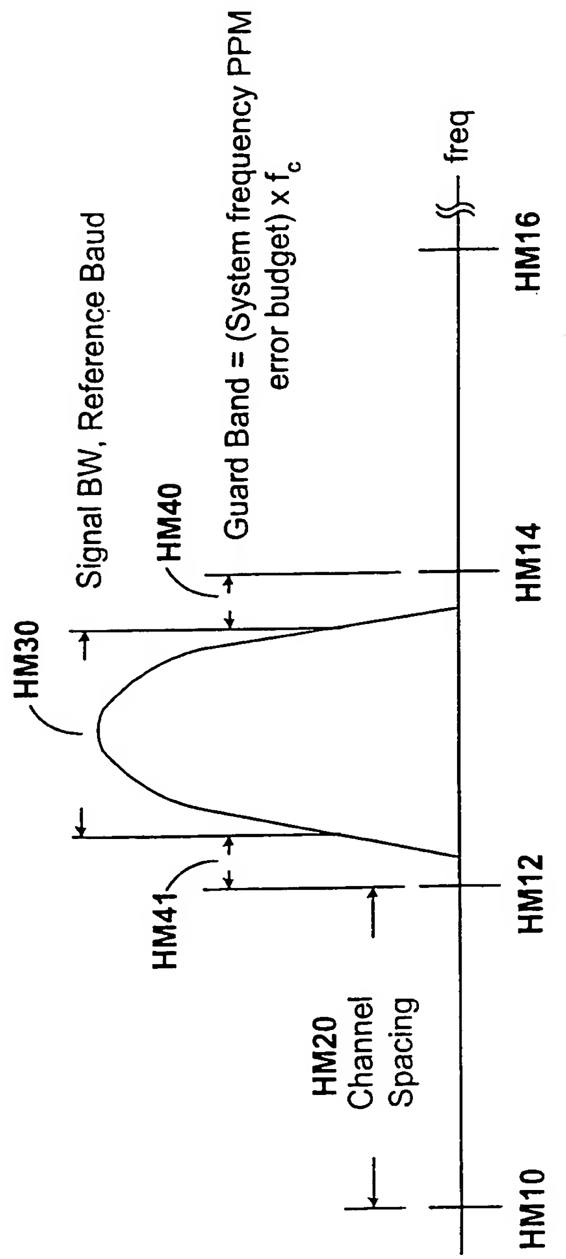
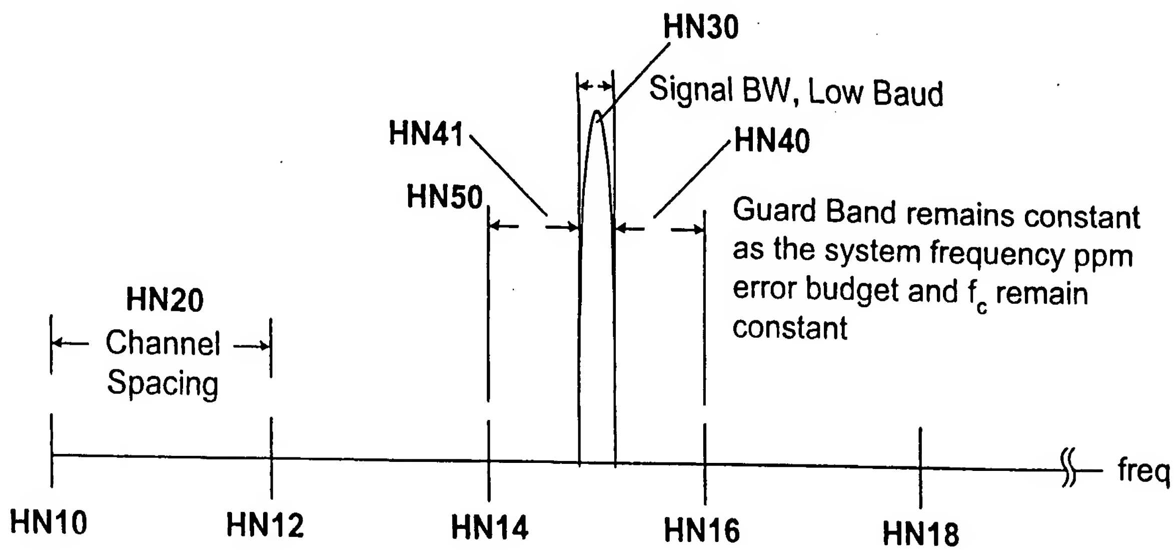

Signal BW, Reference Baud
Guard Band = (System frequency PPM error budget) x f_c
HM30
HM40
HM41
HM20
Channel Spacing
freq
HM10
HM12
HM14
HM16

FIGURE 24



Due to fixed guard band size, reduced baud rates do not proportinately increase the number of usable channels. The above example requires a "wasted" BW of 5X. Also as f_c drives to higher frequency bands the same effect occurs as the required guard band BW increased beyond the received signal BW.

FIGURE 25

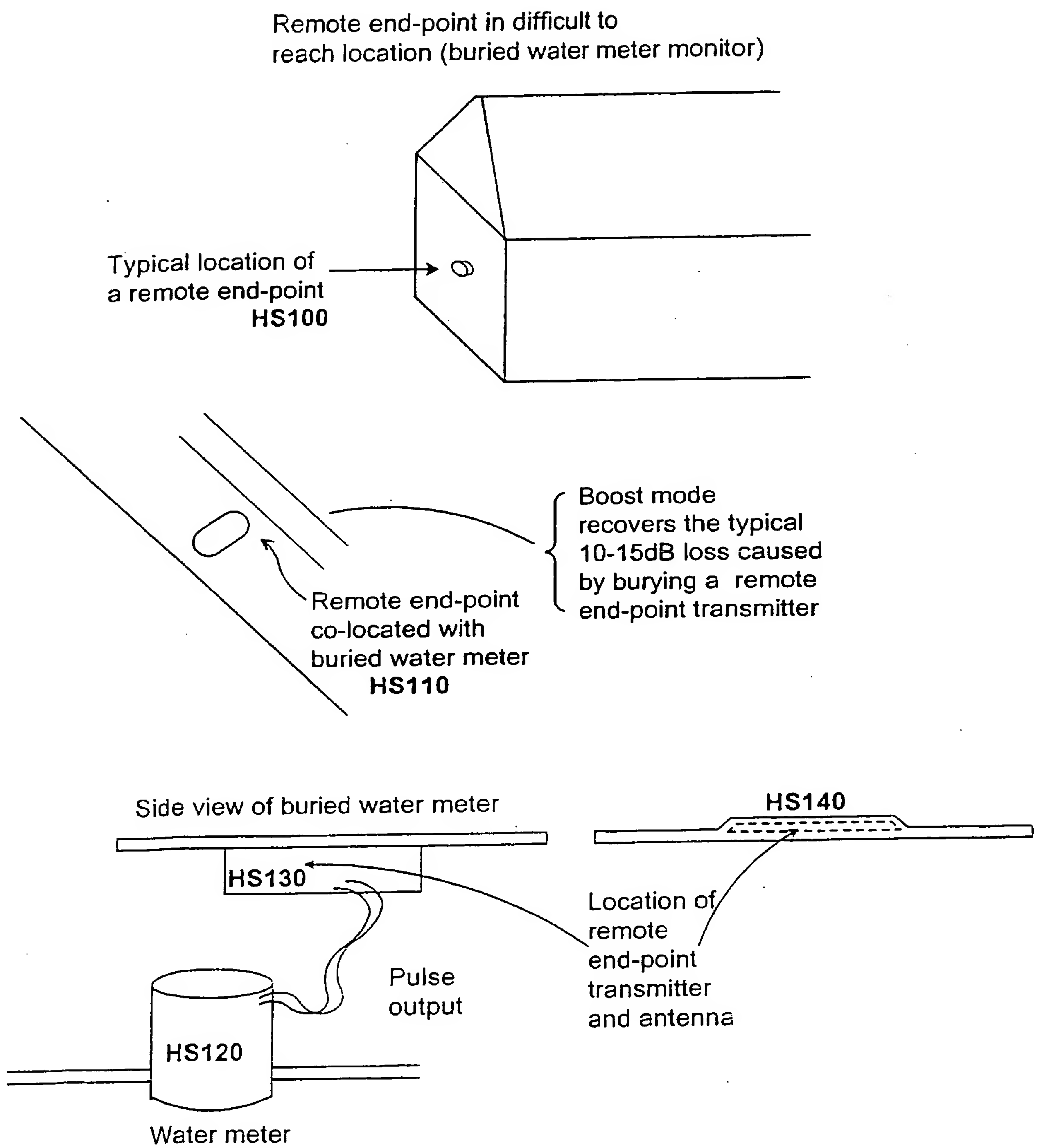
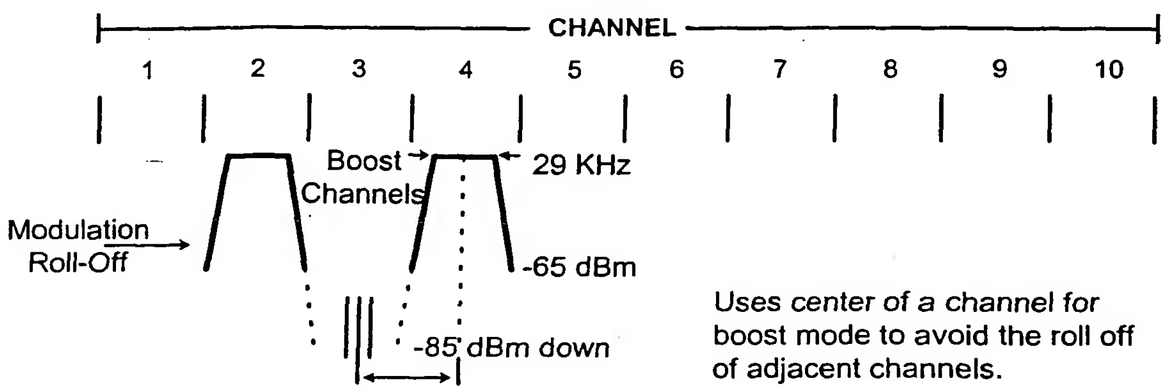

Remote end-point in difficult to reach location (buried water meter monitor)
Typical location of a remote end-point
HS100
Boost mode recovers the typical 10-15dB loss caused by burying a remote end-point transmitter
Remote end-point co-located with buried water meter
HS110
Side view of buried water meter
HS140
HS130
Location of remote end-point transmitter and antenna
Pulse output
HS120
Water meter

FIGURE 26

10 Channel Frequency Plan Preferred Embodiment

Channel #	50 KHz Each
1	Home Gateway, Micro Area Network [can be a unique local modulation/protocol]
2	Reserved for future battery-operated version transceiver (low traffic)
3	Boost Mode (centered in middle of channel)
4	Transmit-only remote end-point ALOHA Operation Channel A, fixed
5	Transmit-only remote end-point ALOHA Operation Channel B, fixed
6	Transmit-only remote end-point ALOHA Operation Channel C, fixed
7	Transmit-only remote end-point ALOHA operation Channel D, fixed (or alternatively mobile applications)
8	Mobile applications (transmit-only & two-way)
9	Reserved for utilities requiring an independent channel (or mobile applications)
10	Reserved for future definition [possible monitor of remote base station repeating signal to eliminate its land lines]



Uses center of a channel for boost mode to avoid the roll off of adjacent channels.

16.6 Kb/s Normal Mode data rate (50 kHz channel separation)
520 b/s Boost Mode (channel separation of 4.2 kHz)
Boost mode assumed in 1 out of 32 installations:

- (16.6 kb/s ÷ 520 Baud) = 32X normal message duration
- The 5 transmit-only ALOHA channels (4,5,6,7 & 8) can all share 5 Boost Mode channels (Approximately 5 boost channels could be received simultaneously, but 8 can fit.)
- 10 Log (16.6 kb/s ÷ 520 Baud) = 15 dB improvement over the normal mode Baud rate

Assumes transmit-only and transceiver remote end-point devices are statistically close to desired frequency; since this is an ALOHA system, it will have a limited impact on throughput (reduces demands on guard band). Alternatively, transceivers can use base station as pilot tune to eliminate its own frequency error.

Fixed location transmit-only remote end-point devices operate in channel A, B, C or D; and mobile GPS locatable transmitters operate in channels 8 and 9.

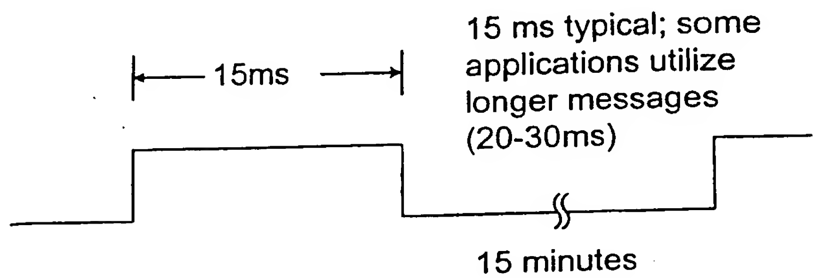
Remote transceivers have 2 main purposes

1) As repeaters of transmit-only remote end-point devices
2) As controllers of remote end-points (outputs)

Home gateway positioned adjacent to a remote end-point transceiver channel; the remote end-point transceiver can switch frequencies "instantly" in DSP software providing I.F. is 110 KHz wide. This means that the base station may not have to receive in Channel 1.

FIGURE 27

Battery Life of Transmit-only Remote End-point



Avg transmit current:

$$\frac{15\text{ms}}{15\text{ min} \cdot 60\text{s}} \cdot 550\text{ mA} = 9.2\ \mu\text{A}$$

Transmit set-up current:

$$\frac{10\text{ms}}{15\text{ min} \cdot 60\text{s}} \cdot 25\text{ mA} = .3\ \mu\text{A}$$

Sleep time current & leakage $\underline{5.0\ \mu\text{A}}$

Total average current: 14.5 μA

Assume a 1.4 AH lithium battery

1.4 AH • 80% derate ÷ 14.5 μA = 72,258 hrs

÷ 24 ÷ 365 = 8.2 years

FIGURE 28

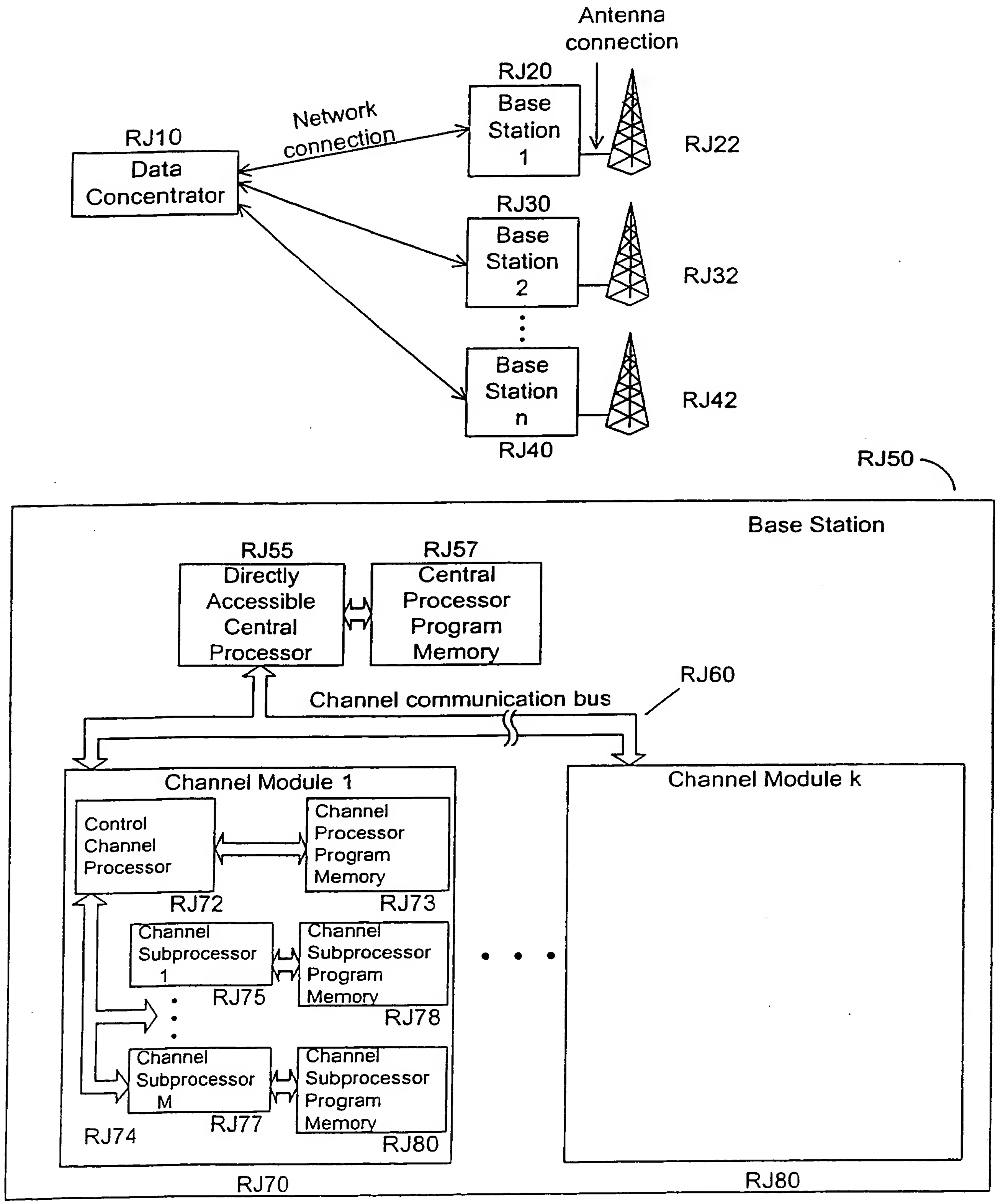
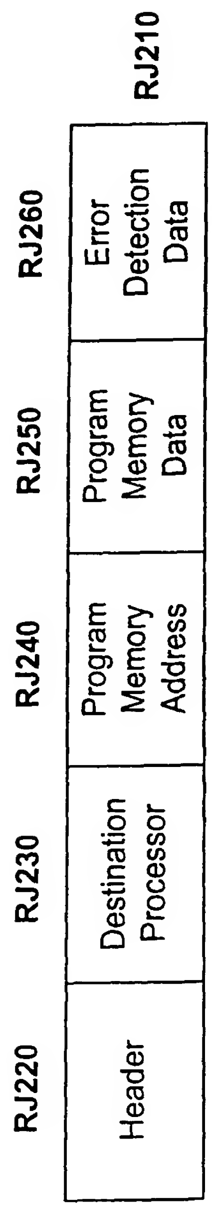

Antenna connection
RJ20
Base Station 1
RJ22
Network connection
RJ10
Data Concentrator
RJ30
Base Station 2
RJ32
Base Station n
RJ42
RJ40
RJ50
Base Station
RJ55
Directly Accessible Central Processor
RJ57
Central Processor Program Memory
RJ60
Channel communication bus
Channel Module 1
Control Channel Processor
Channel Processor Program Memory
RJ72
RJ73
Channel Subprocessor 1
Channel Subprocessor Program Memory
RJ75
RJ78
Channel Subprocessor M
Channel Subprocessor Program Memory
RJ74
RJ77
RJ80
Channel Module k
RJ70
RJ80

FIGURE 29



Remote Processor Program Transfer Protocol Message

FIGURE 30

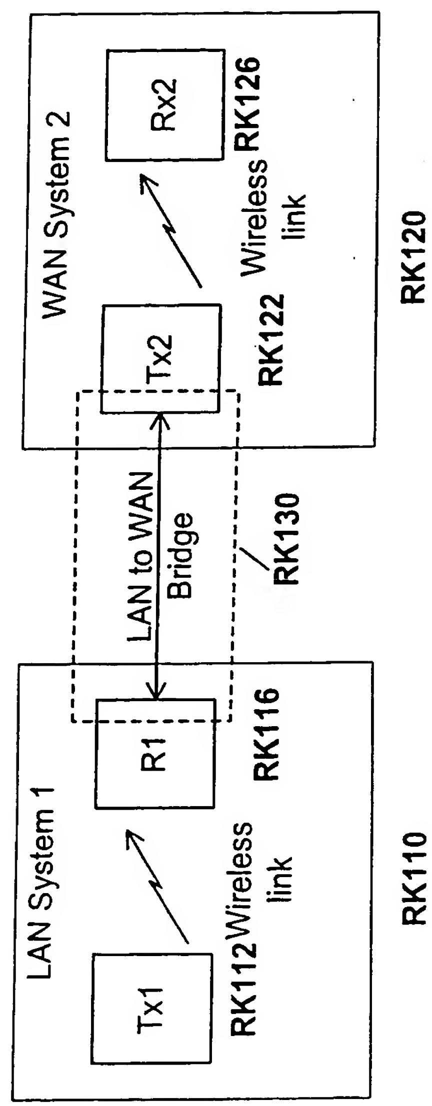

WAN System 2
Tx2
RK122
Wireless link
Rx2
RK126
RK120
LAN to WAN Bridge
RK130
LAN System 1
Tx1
RK112
Wireless link
R1
RK116
RK110

FIGURE 31

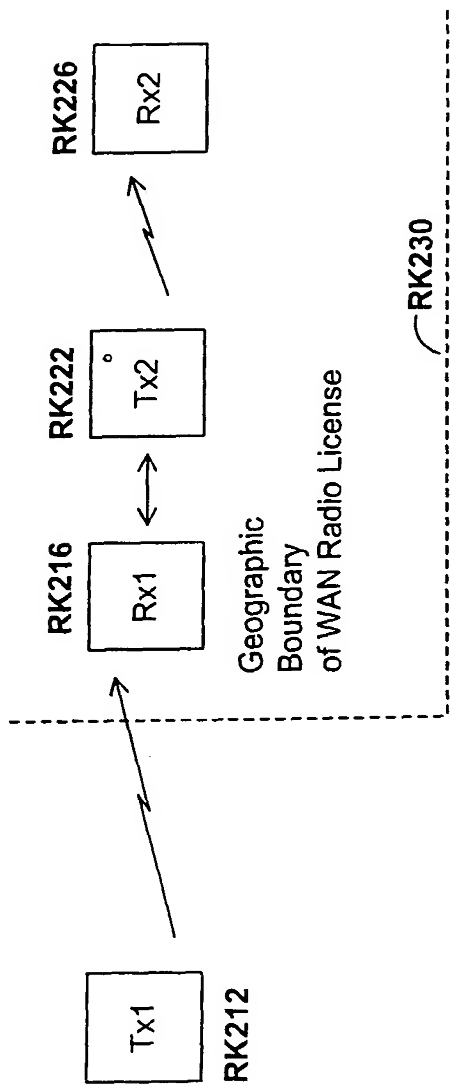

RK226
Rx2
RK222
Tx2
RK216
Rx1
RK230
Geographic
Boundary
of WAN Radio License
Tx1
RK212

FIGURE 32

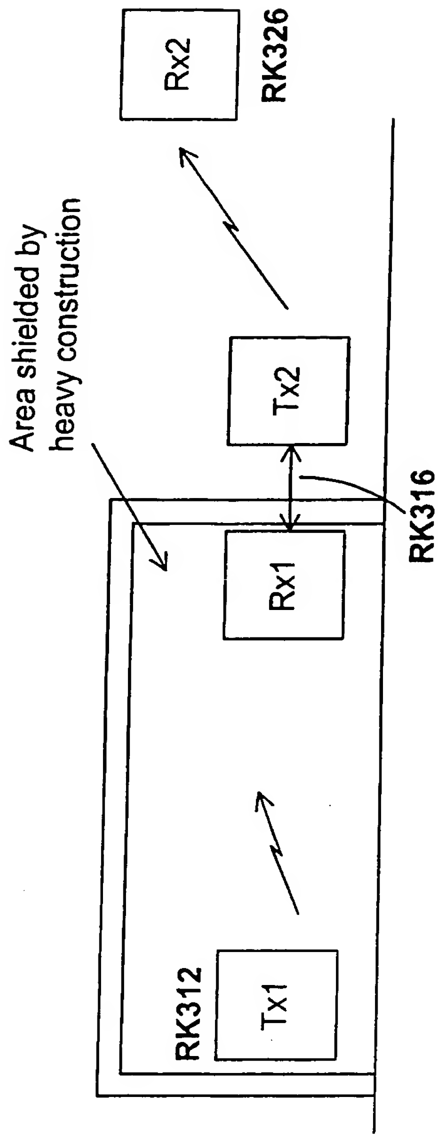

Area shielded by heavy construction
Rx2
RK326
Tx2
RK316
Rx1
Tx1
RK312

FIGURE 33

Special Exception LAN Messages Transferred to WAN

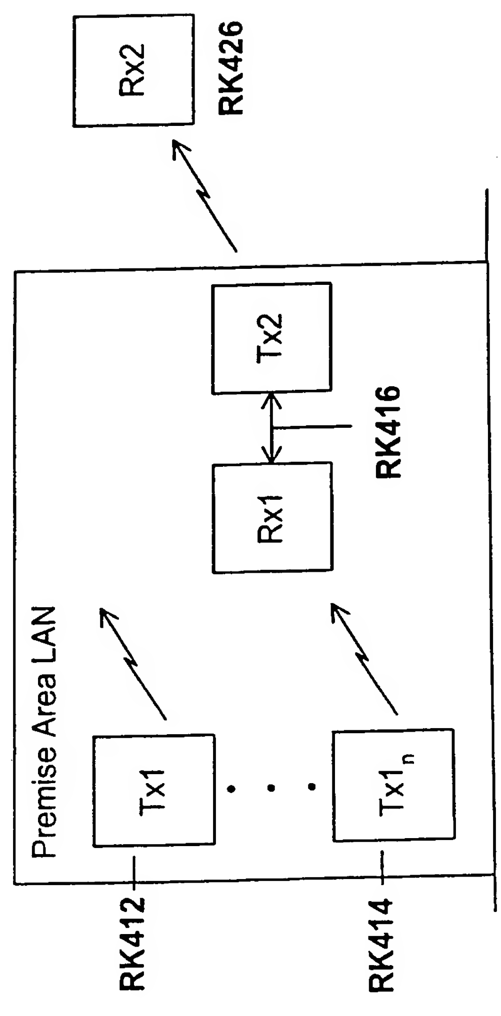


FIGURE 34

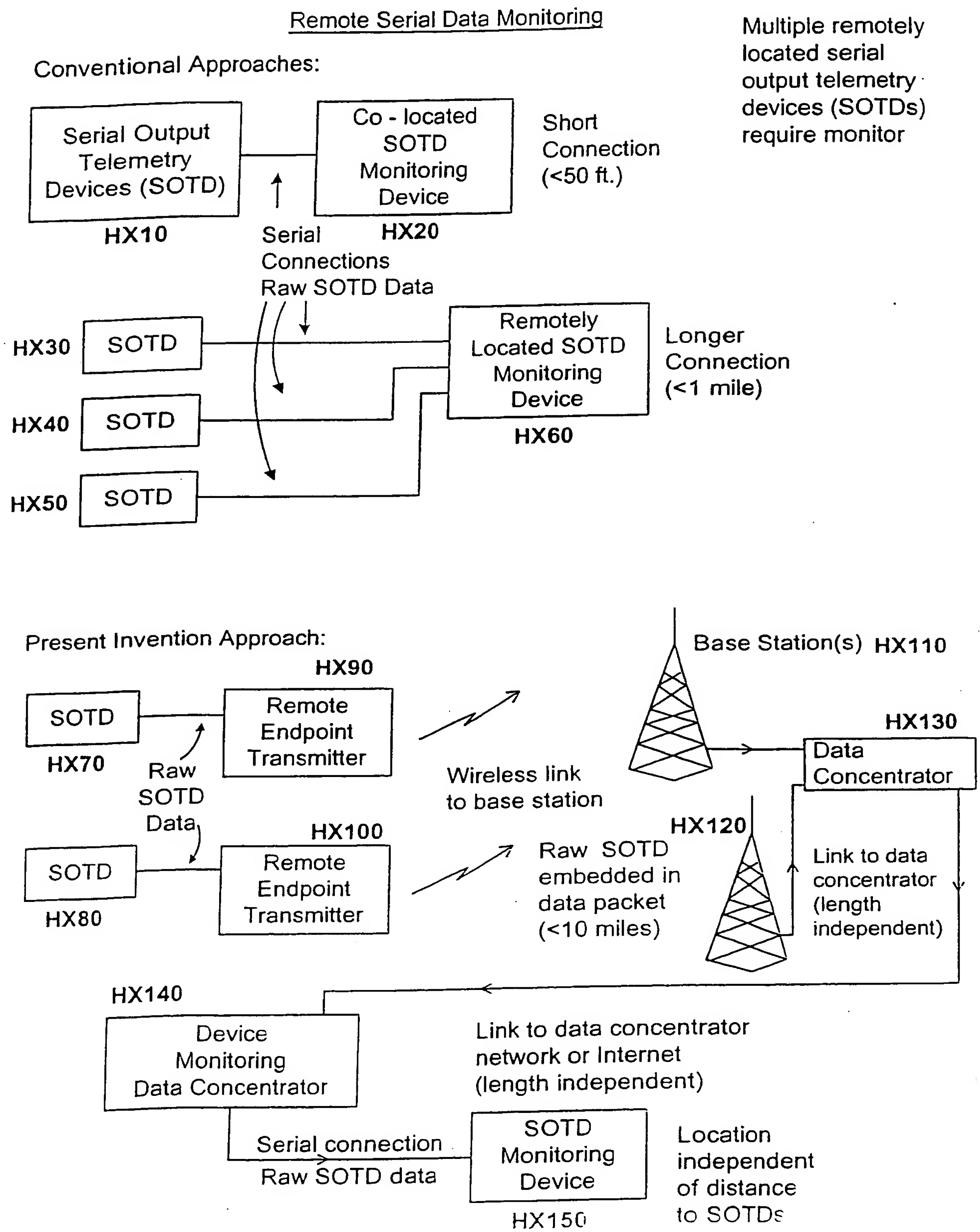

Remote Serial Data Monitoring
Multiple remotely located serial output telemetry devices (SOTDs) require monitor
Conventional Approaches:
Serial Output Telemetry Devices (SOTD)
HX10
Co - located SOTD Monitoring Device
HX20
Short Connection (<50 ft.)
Serial Connections Raw SOTD Data
HX30
SOTD
HX40
SOTD
HX50
SOTD
Remotely Located SOTD Monitoring Device
HX60
Longer Connection (<1 mile)
Present Invention Approach:
SOTD
HX70
Raw SOTD Data
HX90
Remote Endpoint Transmitter
SOTD
HX80
HX100
Remote Endpoint Transmitter
Wireless link to base station
Raw SOTD embedded in data packet (<10 miles)
Base Station(s) HX110
HX120
HX130
Data Concentrator
Link to data concentrator (length independent)
HX140
Device Monitoring Data Concentrator
Link to data concentrator network or Internet (length independent)
Serial connection
Raw SOTD data
SOTD Monitoring Device
HX150
Location independent of distance to SOTDs

FIGURE 35

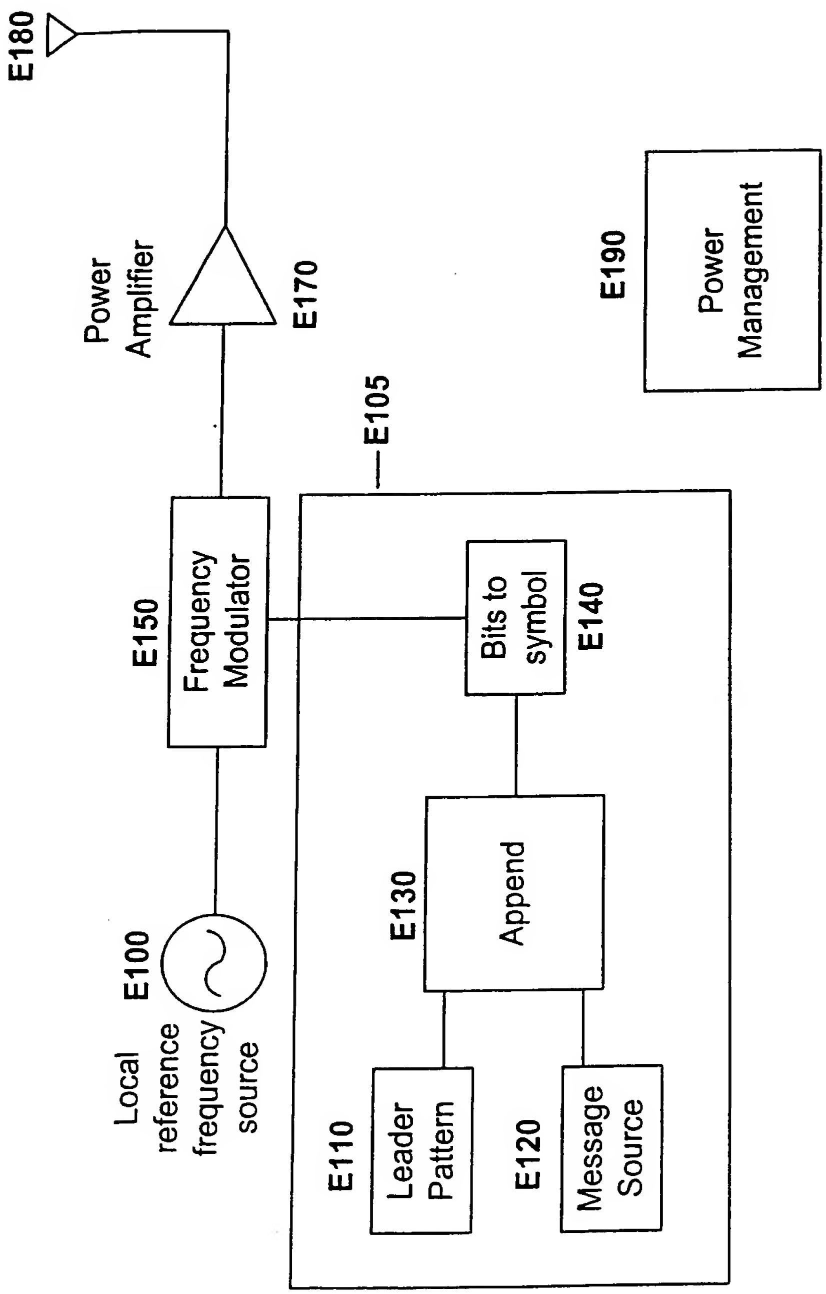

E180
Power Amplifier
E170
E105
E190
Power Management
E150
Frequency Modulator
Bits to symbol
E140
E130
Append
E100
Local reference frequency source
E110
Leader Pattern
E120
Message Source

FIGURE 36

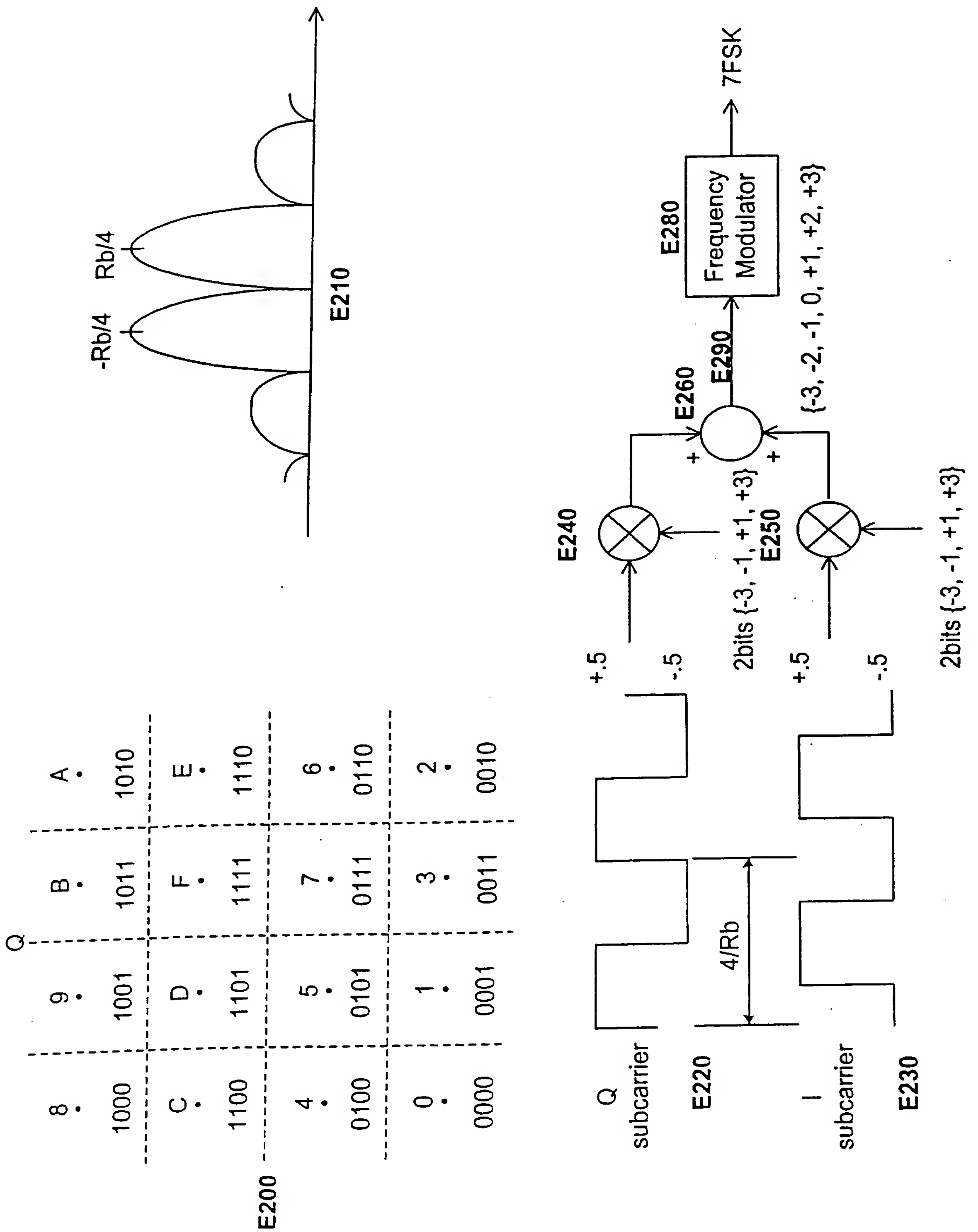

Q
8
1000
9
1001
B
1011
A
1010
C
1100
D
1101
F
1111
E
1110
4
0100
5
0101
7
0111
6
0110
0
0000
1
0001
3
0011
2
0010
E200
-Rb/4
Rb/4
E210
Q subcarrier
E220
I subcarrier
E230
4/Rb
+.5
-.5
2bits {-3, -1, +1, +3}
E240
E250
E260
E290
E280
Frequency Modulator
7FSK
{-3, -2, -1, 0, +1, +2, +3}

FIGURE 37

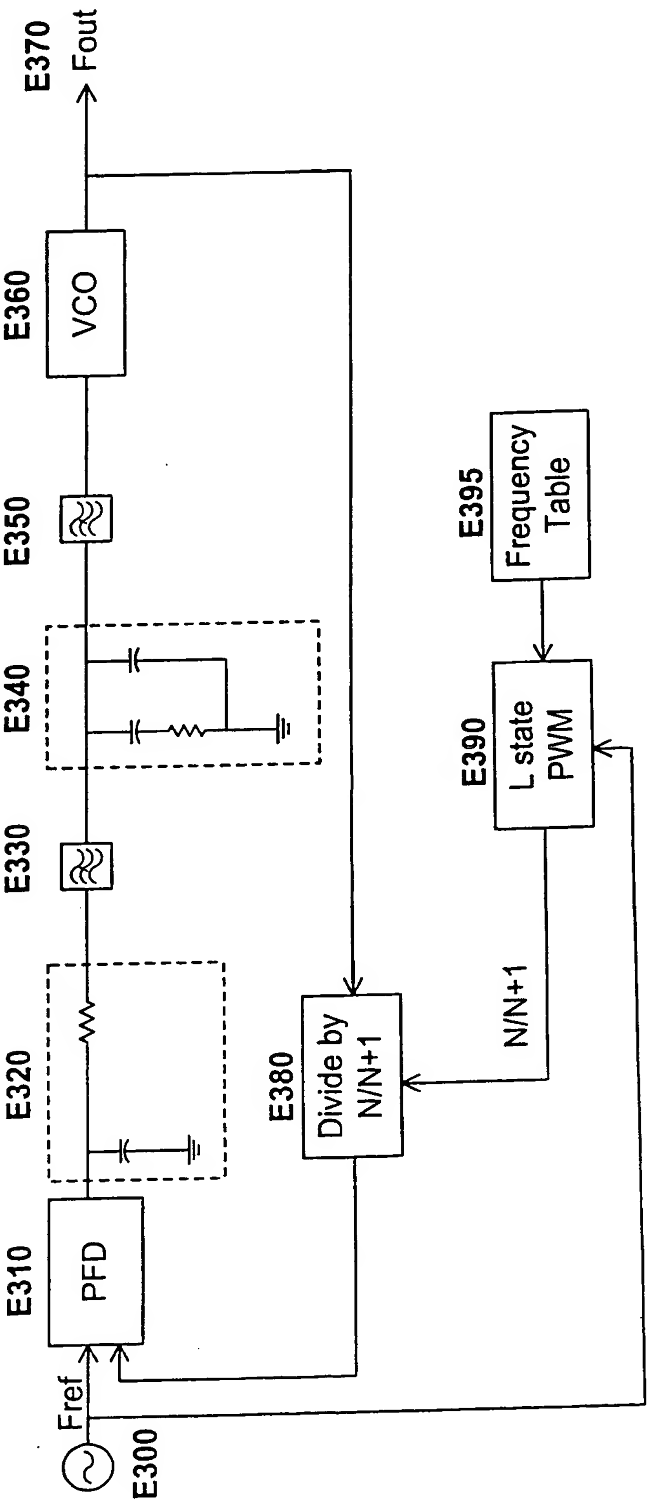

E300
Fref
E310
PFD
E320
E330
E340
E350
E360
VCO
E370
Fout
E380
Divide by N/N+1
N/N+1
E390
L state PWM
E395
Frequency Table

FIGURE 38

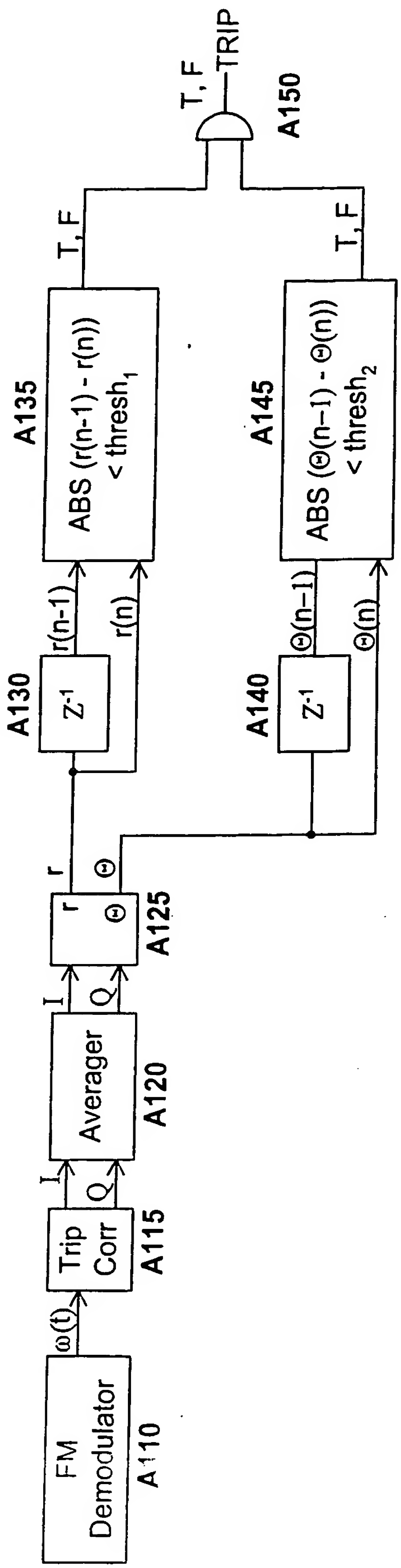

FM Demodulator
A110
ω(t)
Trip Corr
A115
I
Q
Averager
A120
I
Q
r
Θ
A125
r
Θ
Z-1
A130
r(n-1)
r(n)
ABS (r(n-1) - r(n)) < thresh1
A135
T, F
Z-1
A140
Θ(n-1)
Θ(n)
ABS (Θ(n-1) - Θ(n)) < thresh2
A145
T, F
T, F
TRIP
A150

FIGURE 39

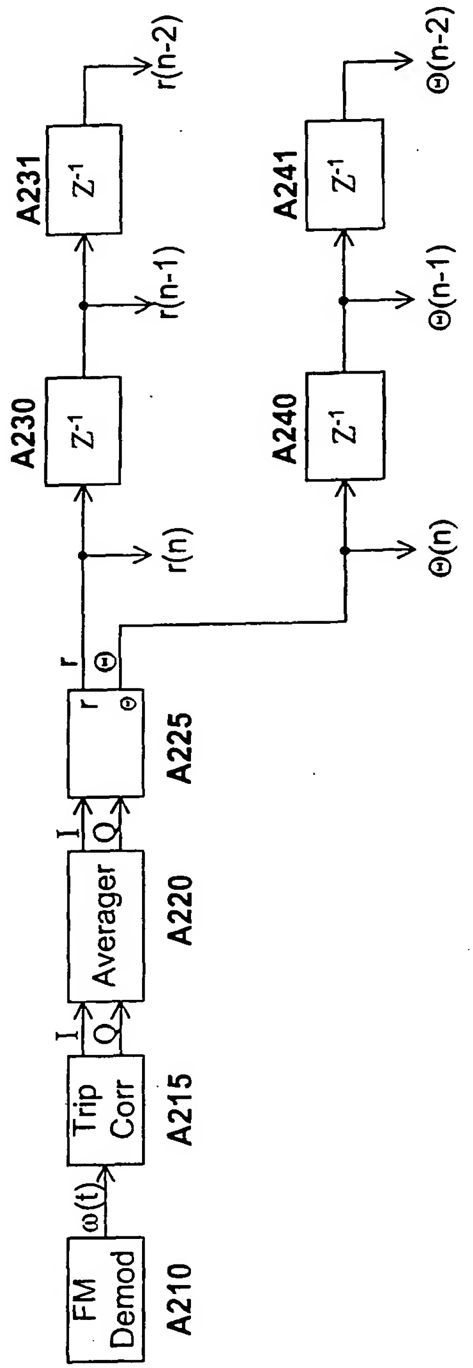

FM Demod
A210
ω(t)
Trip Corr
A215
I
Q
Averager
A220
I
Q
r
Θ
A225
r
Θ
r(n)
Θ(n)
A230
Z-1
r(n-1)
A231
Z-1
r(n-2)
A240
Z-1
Θ(n-1)
A241
Z-1
Θ(n-2)

FIGURE 40

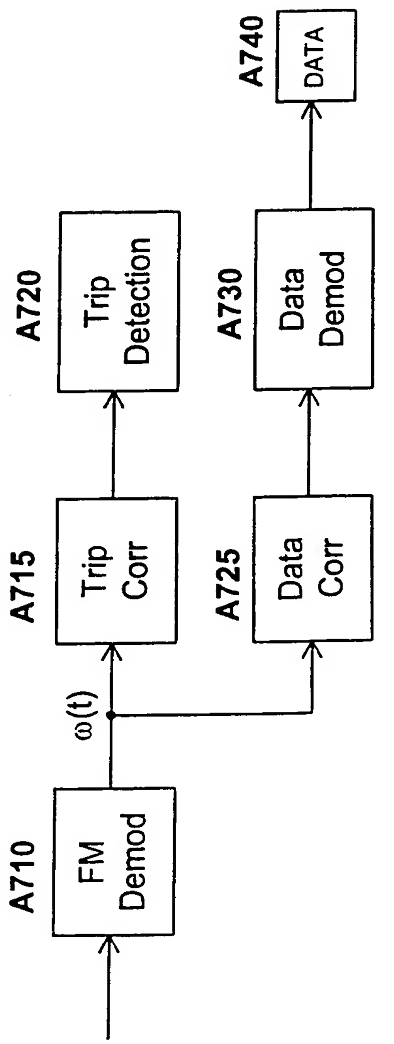

A710
FM Demod
ω(t)
A715
Trip Corr
A720
Trip Detection
A725
Data Corr
A730
Data Demod
A740
DATA

FIGURE 41

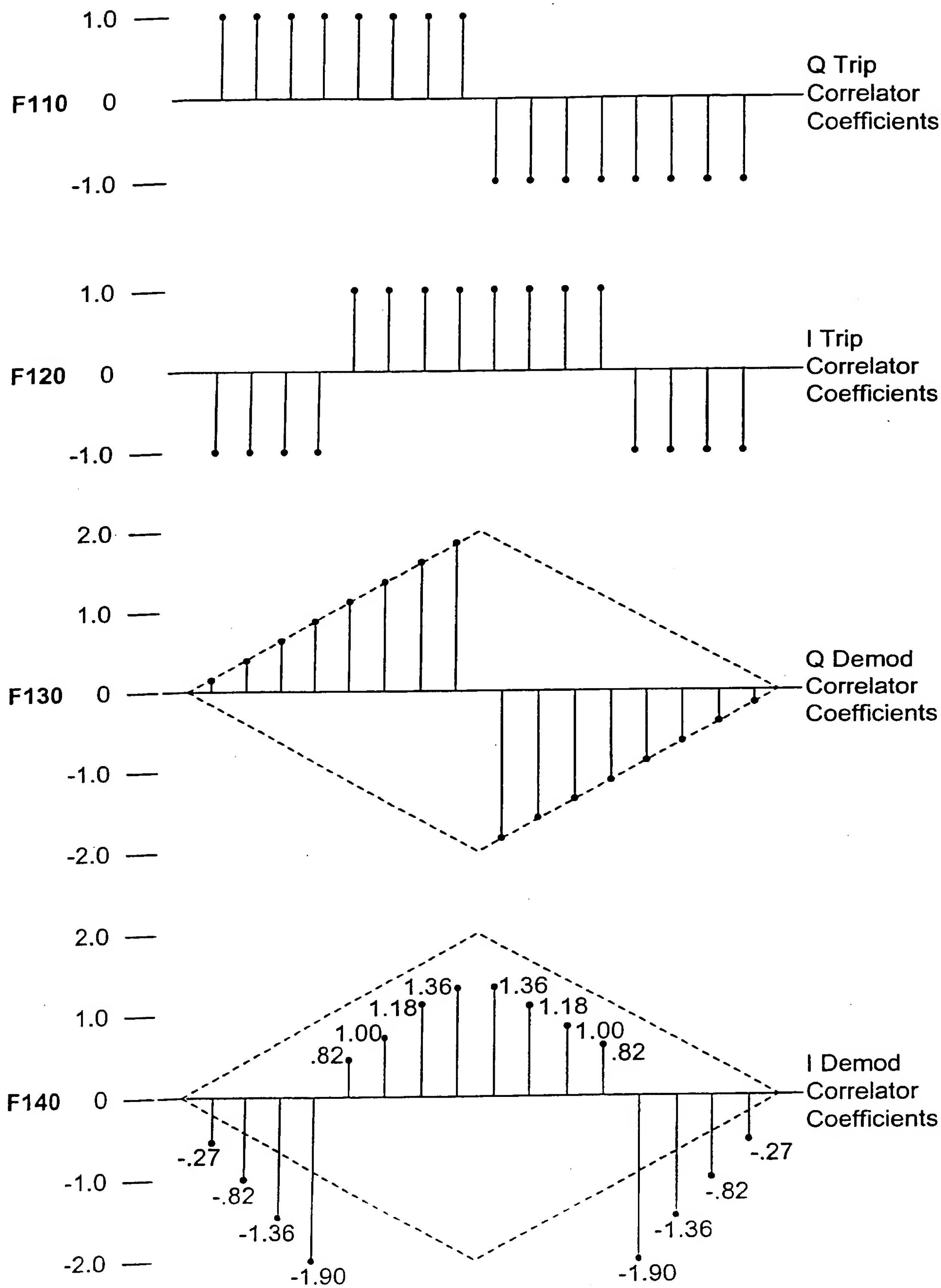

1.0
F110 0
-1.0
Q Trip Correlator Coefficients
1.0
F120 0
-1.0
I Trip Correlator Coefficients
2.0
1.0
F130 0
-1.0
-2.0
Q Demod Correlator Coefficients
2.0
1.0
F140 0
-1.0
-2.0
1.36
1.18
1.00
.82
1.36
1.18
1.00
.82
-.27
-.82
-1.36
-1.90
-.27
-.82
-1.36
-1.90
I Demod Correlator Coefficients

FIGURE 42

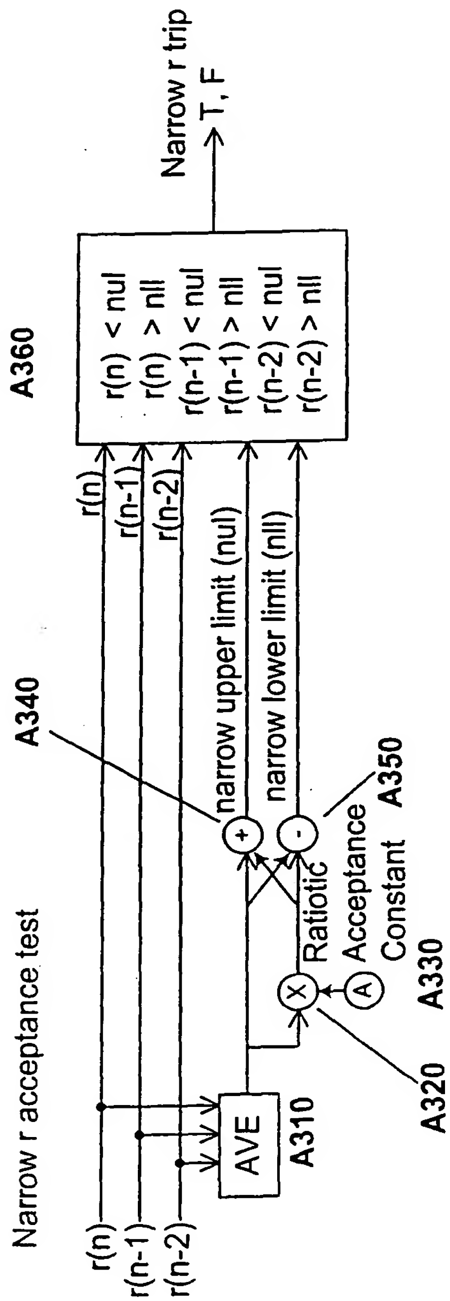

Narrow r acceptance test
r(n)
r(n-1)
r(n-2)
AVE
A310
A320
A330
Ratiotic Acceptance Constant
A
X
+
-
A340
A350
narrow upper limit (nul)
narrow lower limit (nll)
r(n)
r(n-1)
r(n-2)
A360
r(n) < nul
r(n) > nll
r(n-1) < nul
r(n-1) > nll
r(n-2) < nul
r(n-2) > nll
Narrow r trip
T, F

FIGURE 43

Wide r acceptance test

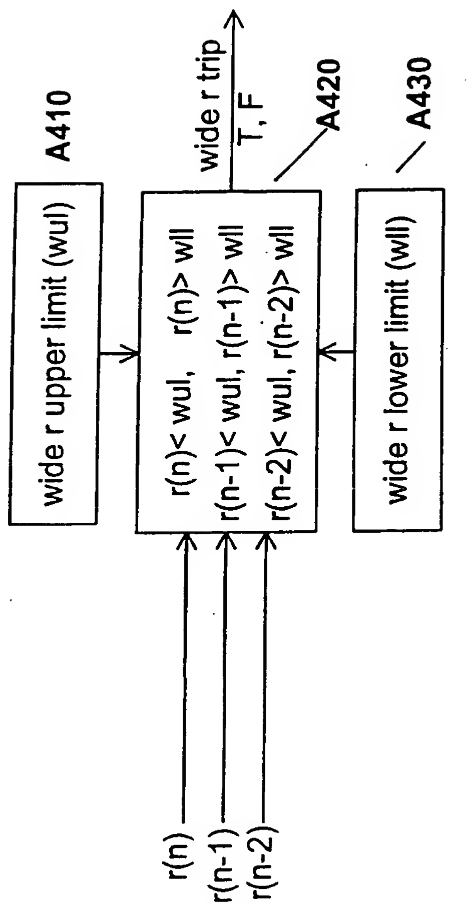


FIGURE 44

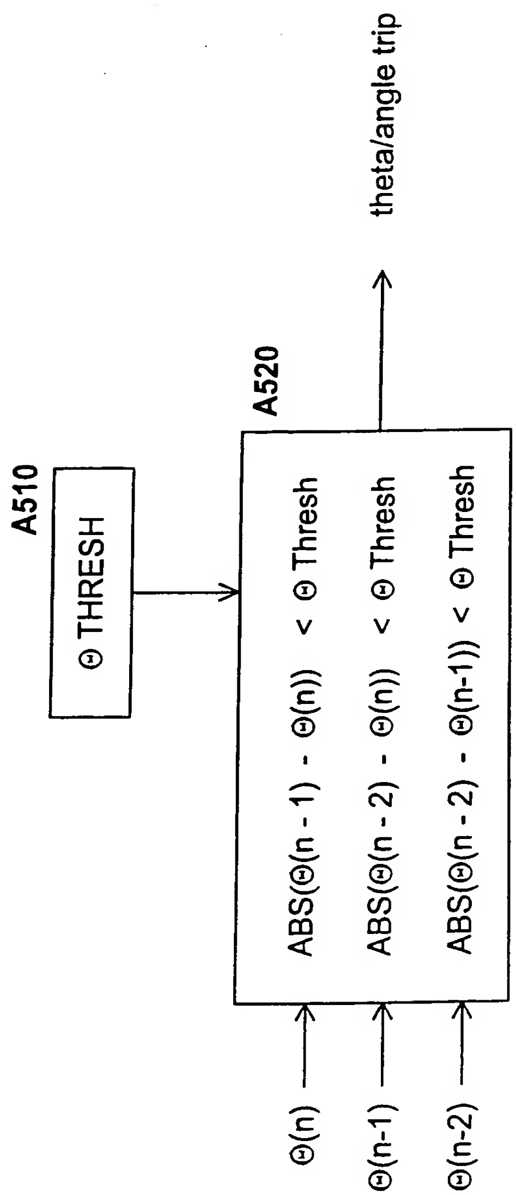

A510
Θ THRESH
A520
ABS(Θ(n - 1) - Θ(n)) < Θ Thresh
ABS(Θ(n - 2) - Θ(n)) < Θ Thresh
ABS(Θ(n - 2) - Θ(n-1)) < Θ Thresh
theta/angle trip
Θ(n)
Θ(n-1)
Θ(n-2)

FIGURE 45

r theta trip algorithm

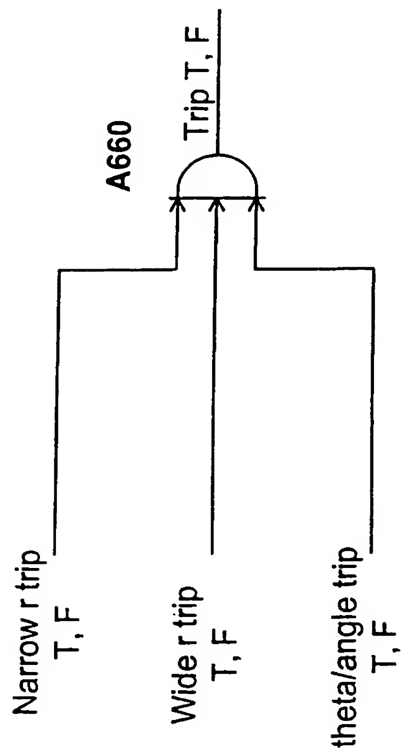


FIGURE 46

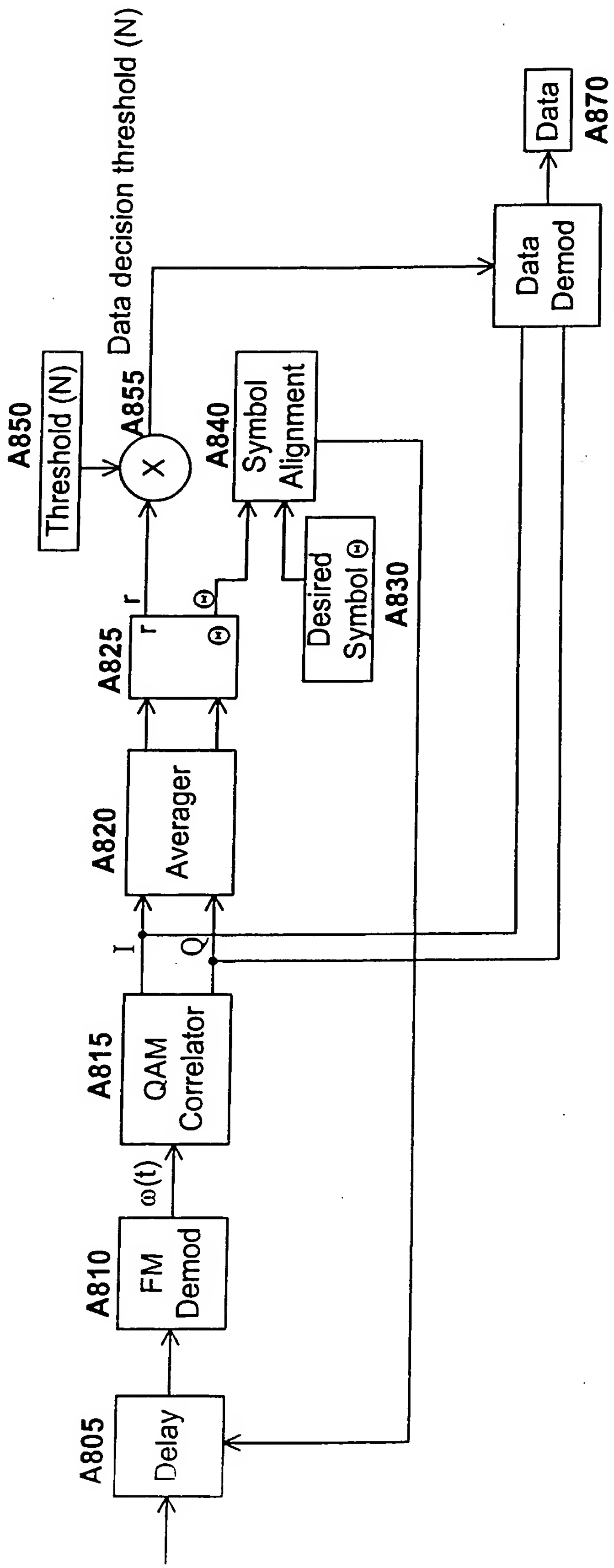

A805
Delay
A810
FM Demod
ω(t)
A815
QAM Correlator
I
Q
A820
Averager
A825
r
Θ
A830
Desired Symbol Θ
A840
Symbol Alignment
A850
Threshold (N)
A855
X
Data decision threshold (N)
A860
Data Demod
A870
Data

FIGURE 47

Data Decision Threshold Scale Factor

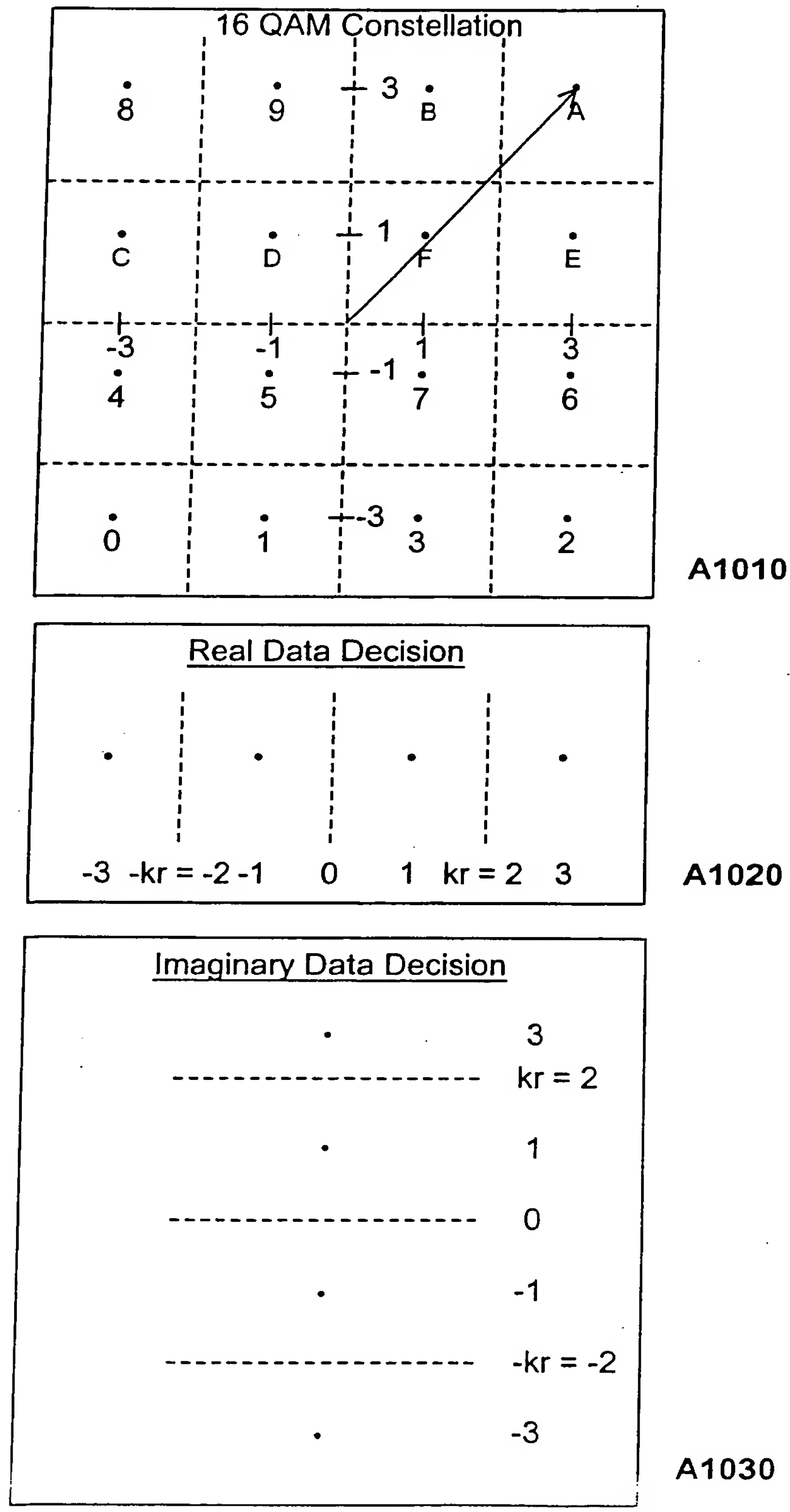


FIGURE 48

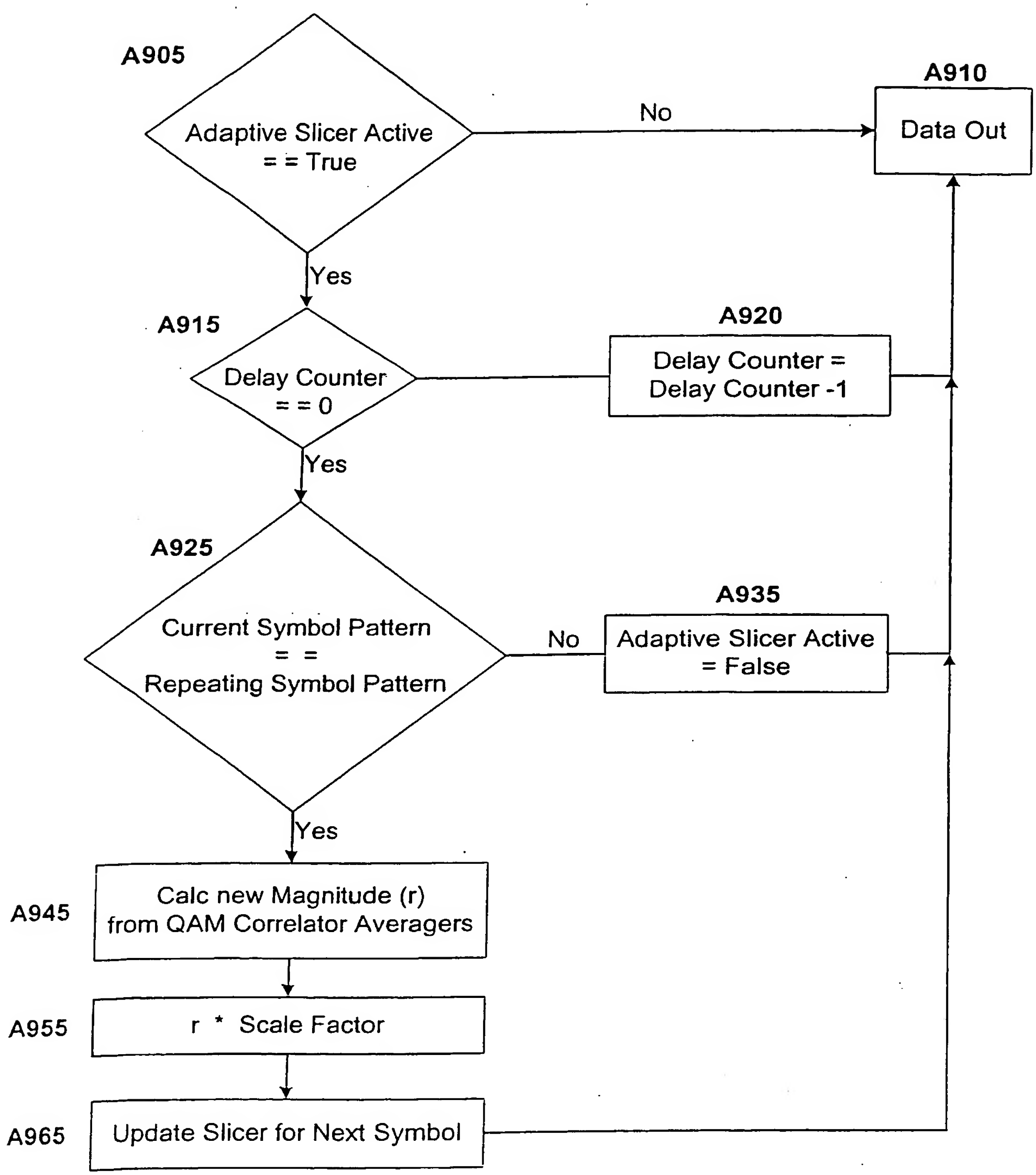

A905
Adaptive Slicer Active = = True
No
A910
Data Out
Yes
A915
Delay Counter = = 0
A920
Delay Counter = Delay Counter -1
Yes
A925
Current Symbol Pattern = = Repeating Symbol Pattern
No
A935
Adaptive Slicer Active = False
Yes
A945
Calc new Magnitude (r) from QAM Correlator Averagers
A955
r * Scale Factor
A965
Update Slicer for Next Symbol

FIGURE 49

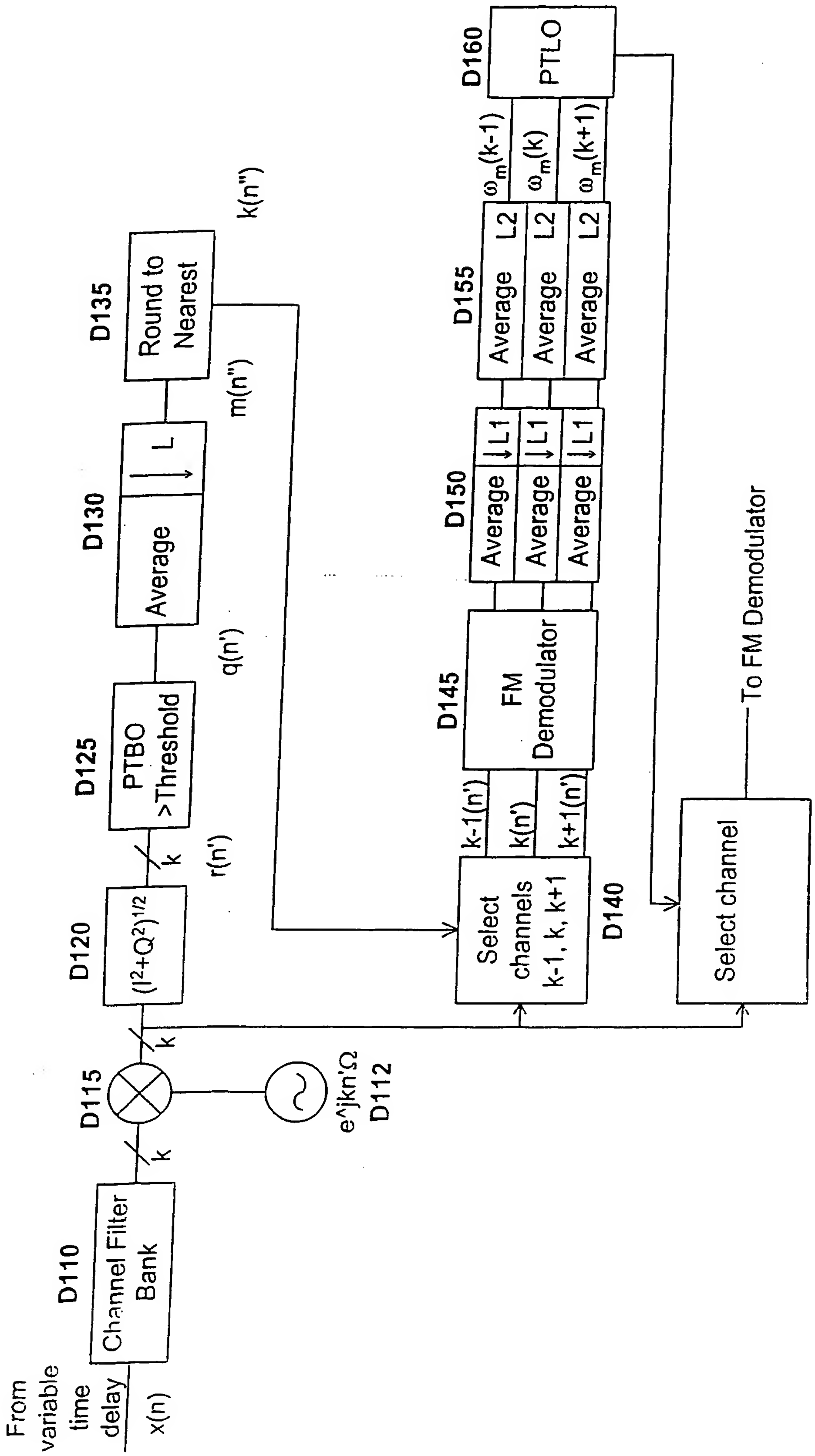

From variable time delay
x(n)
D110
Channel Filter Bank
k
D115
D112
e^jkn'Ω
k
D120
(I²+Q²)^1/2
k
r(n')
D125
PTBO >Threshold
q(n')
D130
Average
↓L
m(n")
D135
Round to Nearest
k(n")
D140
Select channels k-1, k, k+1
k-1(n')
k(n')
k+1(n')
D145
FM Demodulator
D150
Average ↓L1
Average ↓L1
Average ↓L1
D155
Average L2
Average L2
Average L2
ωm(k-1)
ωm(k)
ωm(k+1)
D160
PTLO
D165
Select channel
To FM Demodulator

FIGURE 50

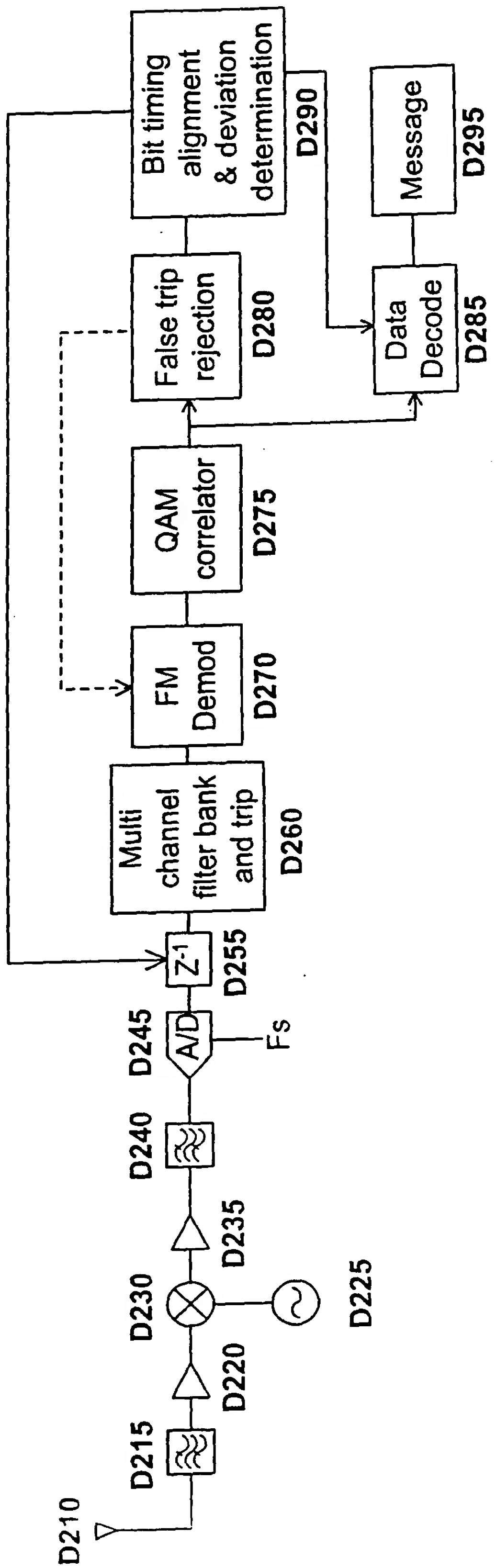

D210
D215
D220
D230
D225
D235
D240
D245
A/D
Fs
D255
Z-1
Multi channel filter bank and trip
D260
FM Demod
D270
QAM correlator
D275
False trip rejection
D280
Bit timing alignment & deviation determination
D290
Data Decode
D285
Message
D295

FIGURE 51

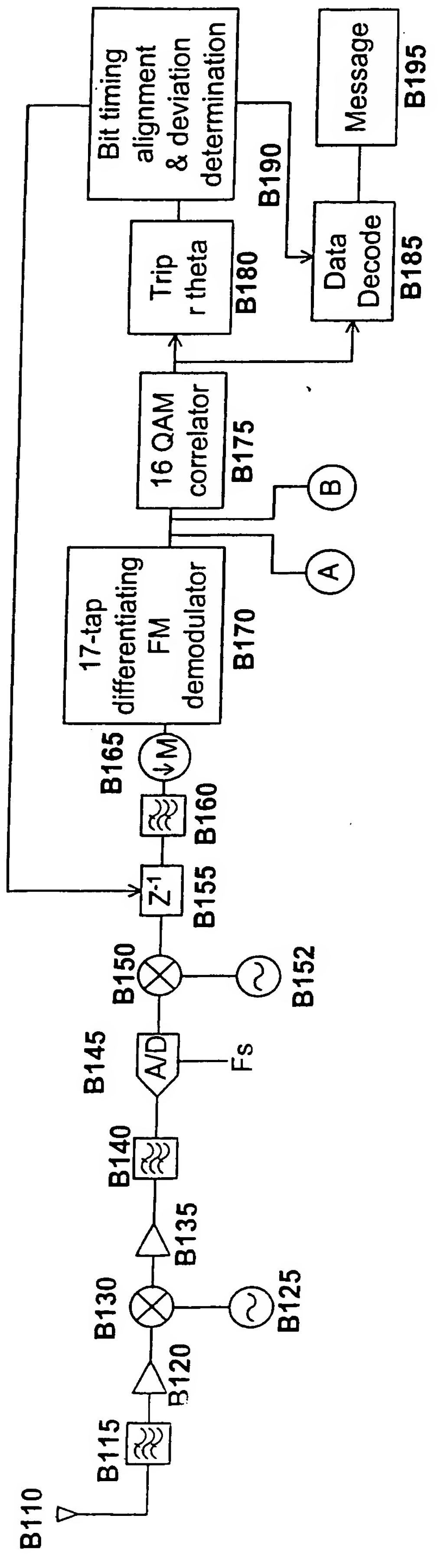
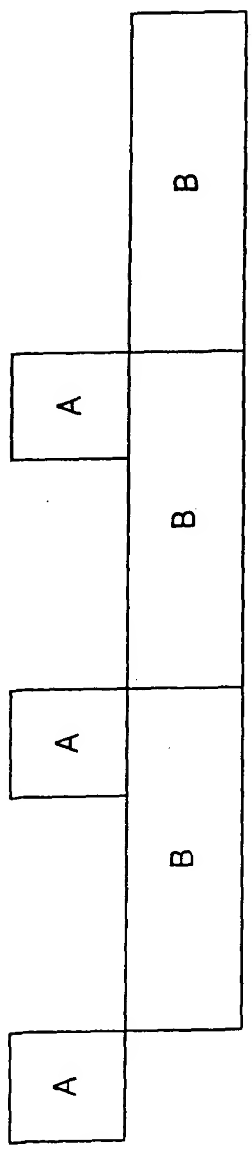

B110
B115
B120
B130
B125
B135
B140
B145
A/D
Fs
B150
B152
B155
Z-1
B160
B165
↓M
17-tap differentiating FM demodulator
B170
A
B
16 QAM correlator
B175
Trip r theta
B180
Bit timing alignment & deviation determination
B190
Data Decode
B185
Message
B195

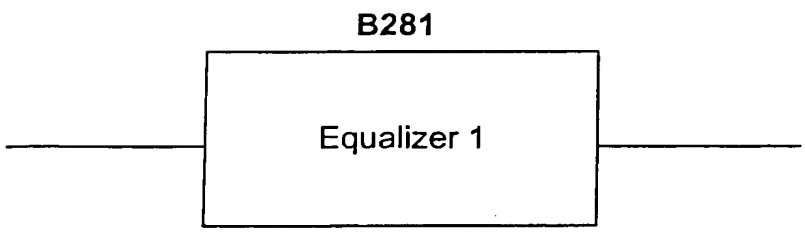
FIGURE 52



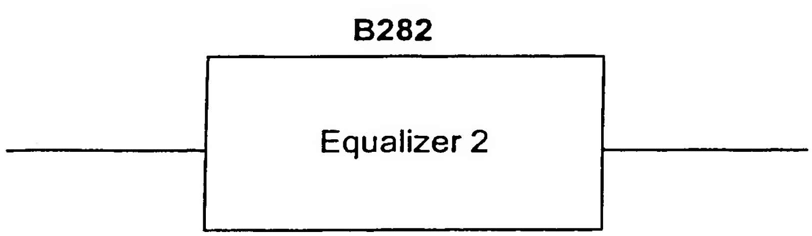
A = Task local reference & settle

B = Multichannel signal detection

FIGURE 53



Insert at (A) in Figure B1



Insert at (B) in Figure B1

FIGURE 54

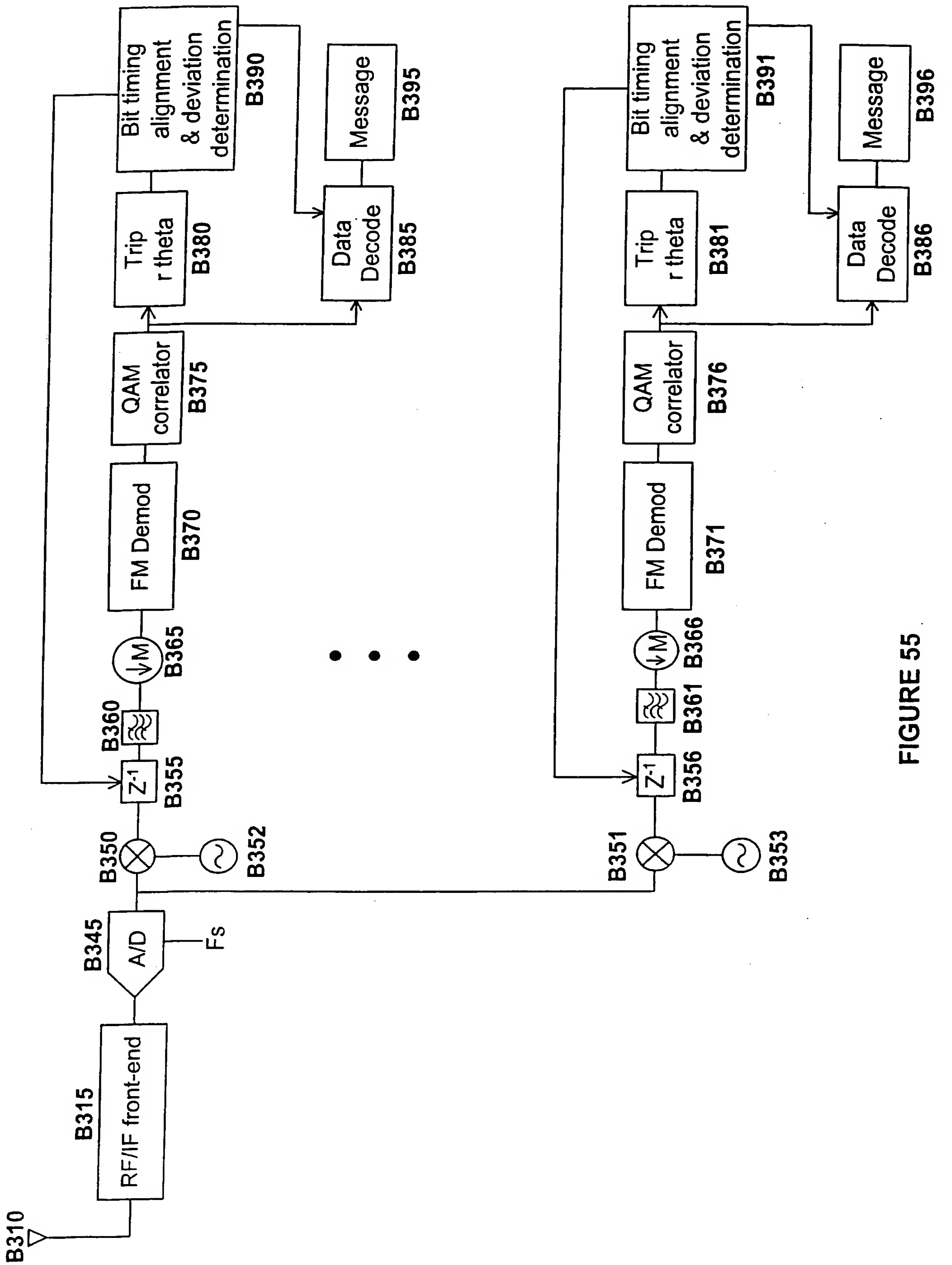

B310
RF/IF front-end
B315
A/D
B345
Fs
B350
B352
Z-1
B355
B360
B365
FM Demod
B370
QAM correlator
B375
Trip r theta
B380
Bit timing alignment & deviation determination
B390
Data Decode
B385
Message
B395
B351
B353
Z-1
B356
B361
B366
FM Demod
B371
QAM correlator
B376
Trip r theta
B381
Bit timing alignment & deviation determination
B391
Data Decode
B386
Message
B396

FIGURE 55

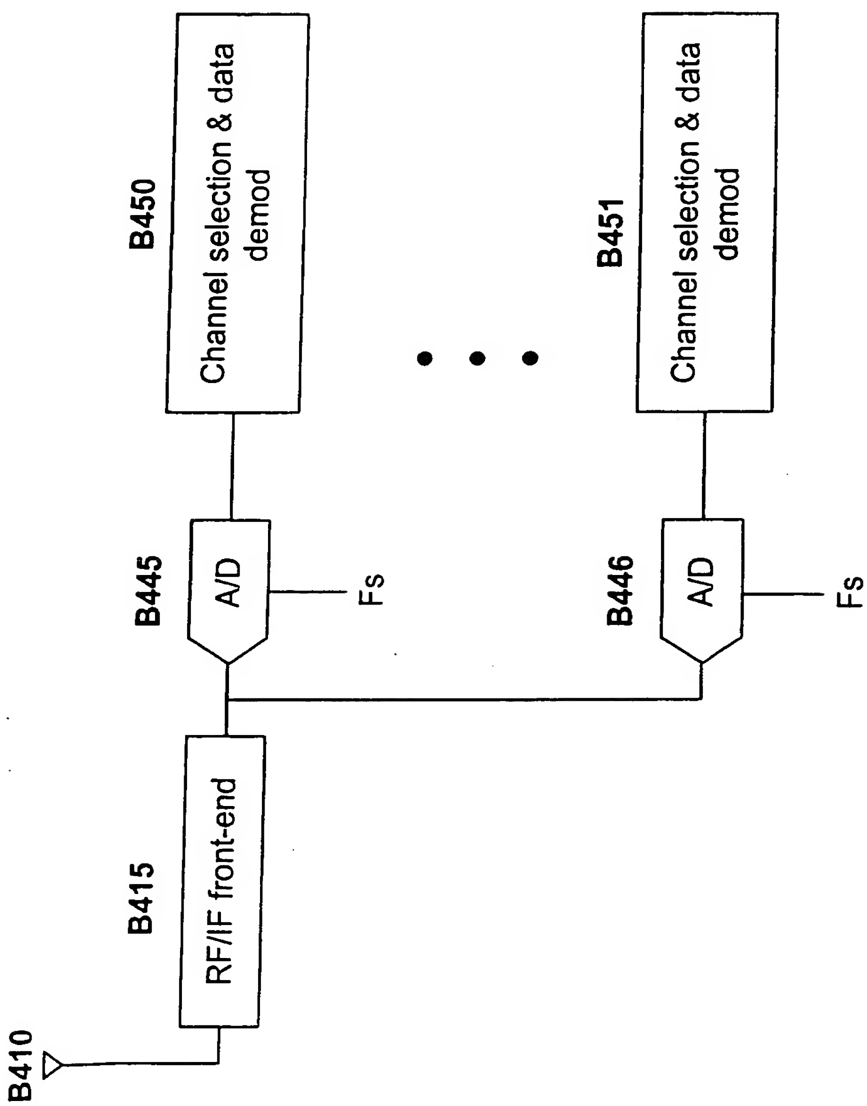

B410
B415
RF/IF front-end
B445
A/D
Fs
B446
A/D
Fs
B450
Channel selection & data demod
B451
Channel selection & data demod

FIGURE 56

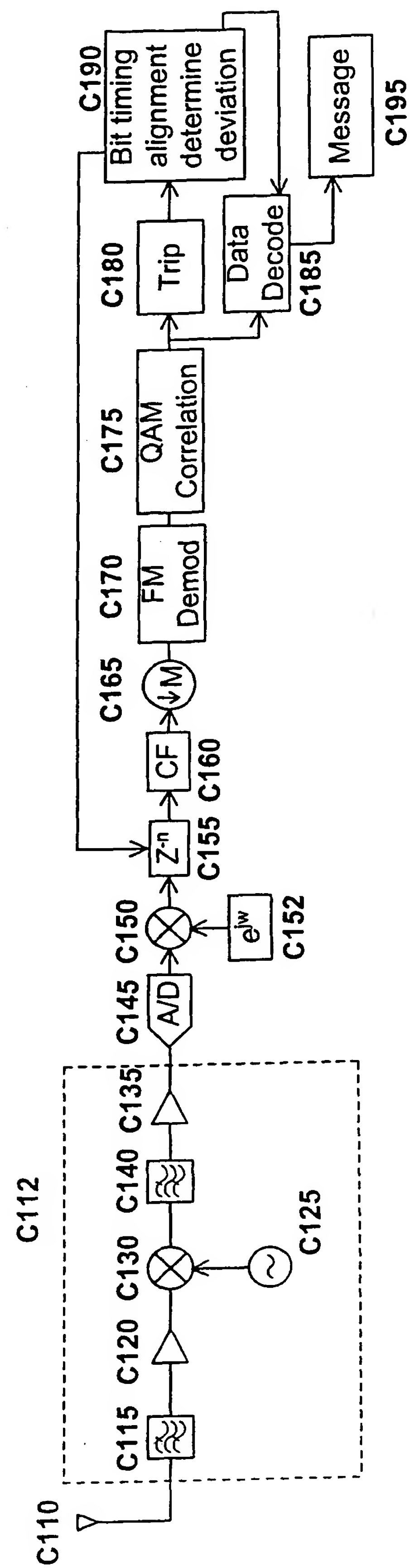

C110
C112
C115
C120
C130
C125
C140
C135
C145
A/D
C150
e^{jw}
C152
Z^{-n}
C155
CF
C160
↓M
C165
FM Demod
C170
QAM Correlation
C175
Trip
C180
Data Decode
C185
Bit timing alignment determine deviation
C190
Message
C195

FIGURE 57

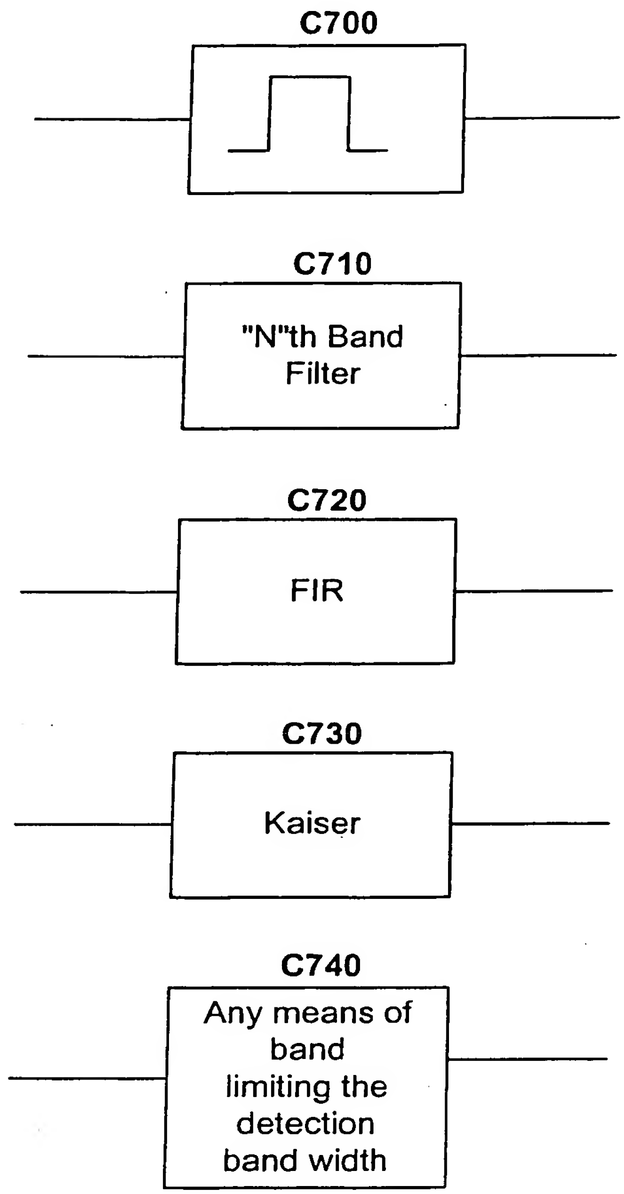

C700
C710
"N"th Band Filter
C720
FIR
C730
Kaiser
C740
Any means of band limiting the detection band width

FIGURE 58

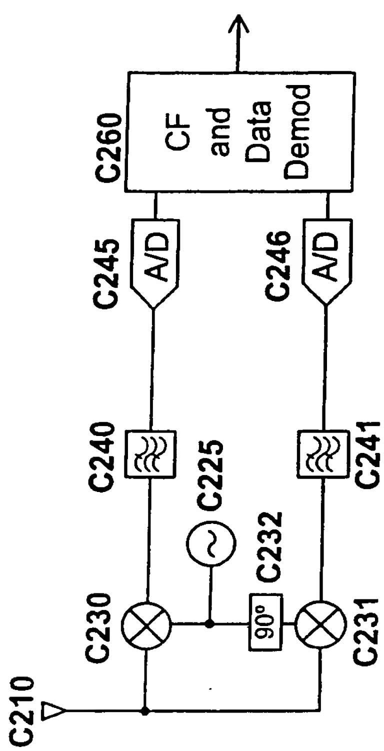

C210
C230
C231
C232
90°
C225
C240
C241
C245
A/D
C246
A/D
C260
CF and Data Demod

FIGURE 59

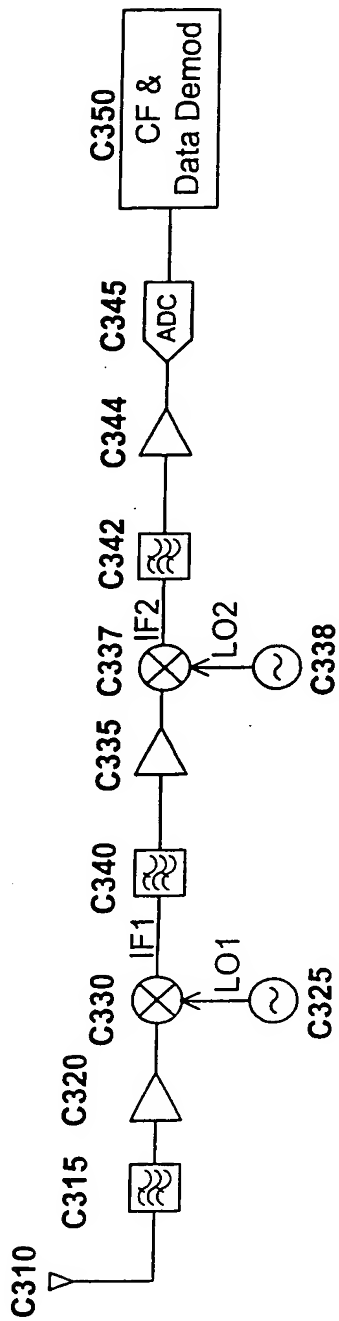

C310
C315
C320
C330
LO1
C325
IF1
C340
C335
C337
LO2
C338
IF2
C342
C344
C345
ADC
C350
CF &
Data Demod

FIGURE 60

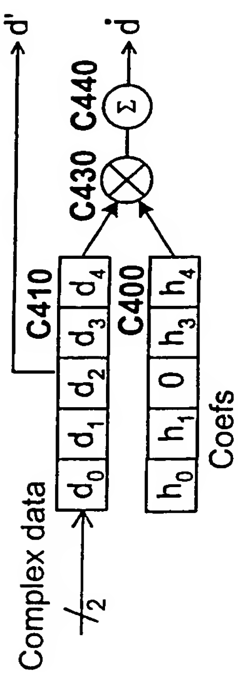


FIGURE 61
PRIOR ART

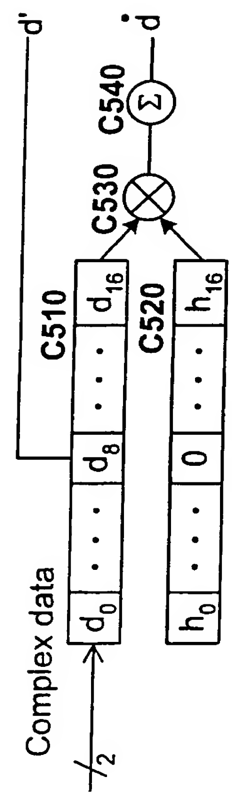


FIGURE 62

Symbol Nibble	FSK Freq Pattern			
F	0	1	0	-1
E	-1	2	1	-2
D	1	0	-1	0
C	2	-1	-2	1
B	1	2	-1	-2
A	0	3	0	-3
9	2	1	-2	-1
8	3	0	-3	0
7	-1	0	1	0
6	-2	1	2	-1
5	0	-1	0	1
4	1	-2	-1	2
3	-2	-1	2	1
2	-3	0	3	0
1	-1	-2	1	2
0	0	-3	0	3

FIGURE 63

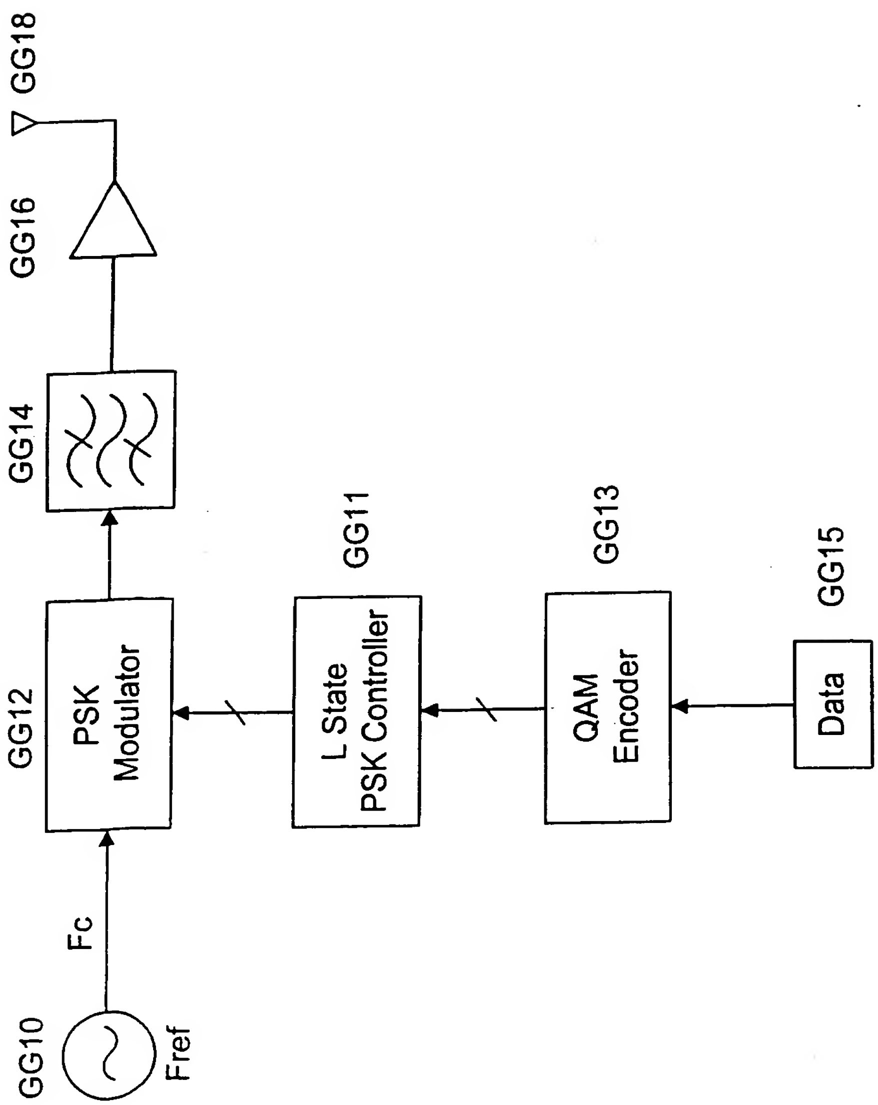

GG10
Fref
Fc
GG12
PSK
Modulator
GG14
GG16
GG18
GG11
L State
PSK Controller
GG13
QAM
Encoder
GG15
Data

FIGURE 64

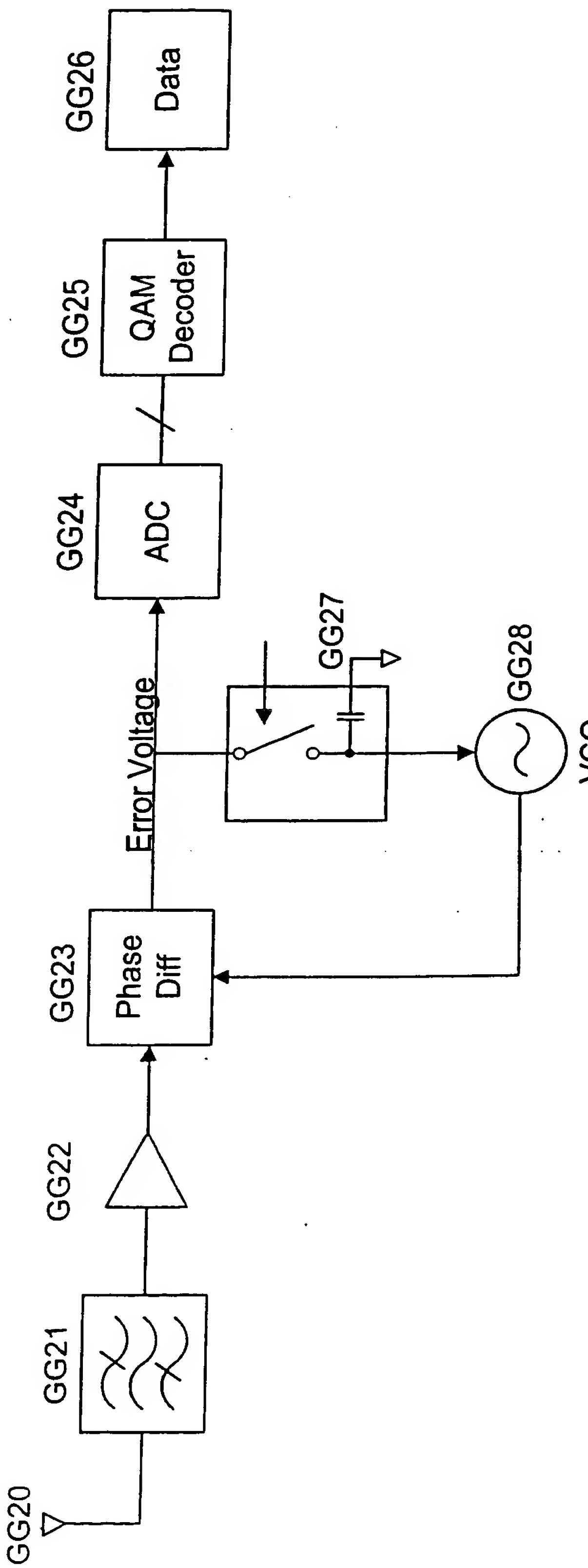

GG20
GG21
GG22
GG23
Phase Diff
Error Voltage
GG24
ADC
GG25
QAM Decoder
GG26
Data
GG27
GG28
VCO

FIGURE 65

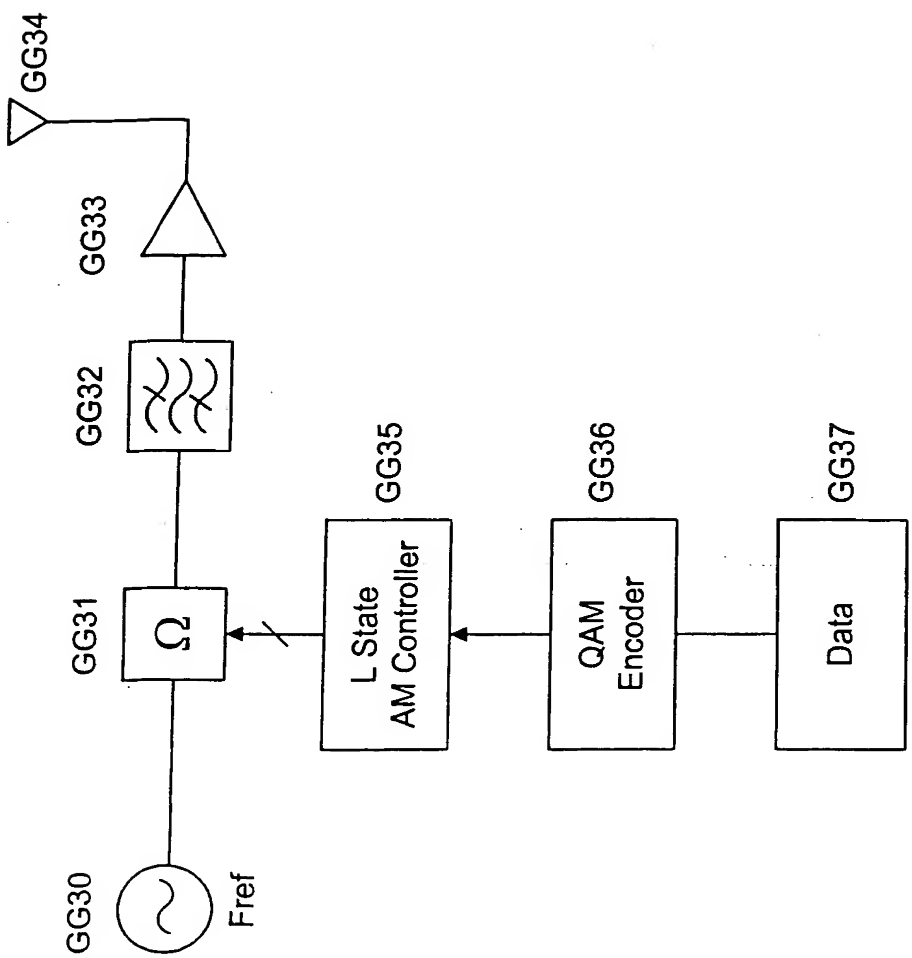

GG30
Fref
GG31
Ω
GG32
GG33
GG34
GG35
L State
AM Controller
GG36
QAM
Encoder
GG37
Data

FIGURE 66

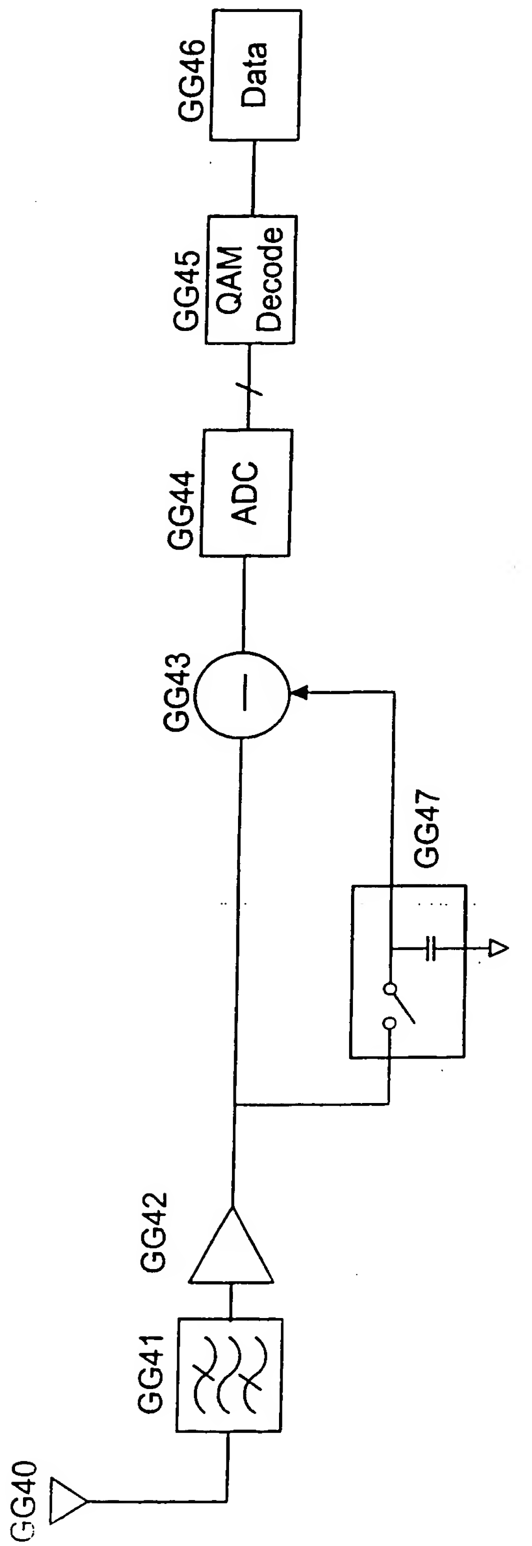


FIGURE 67

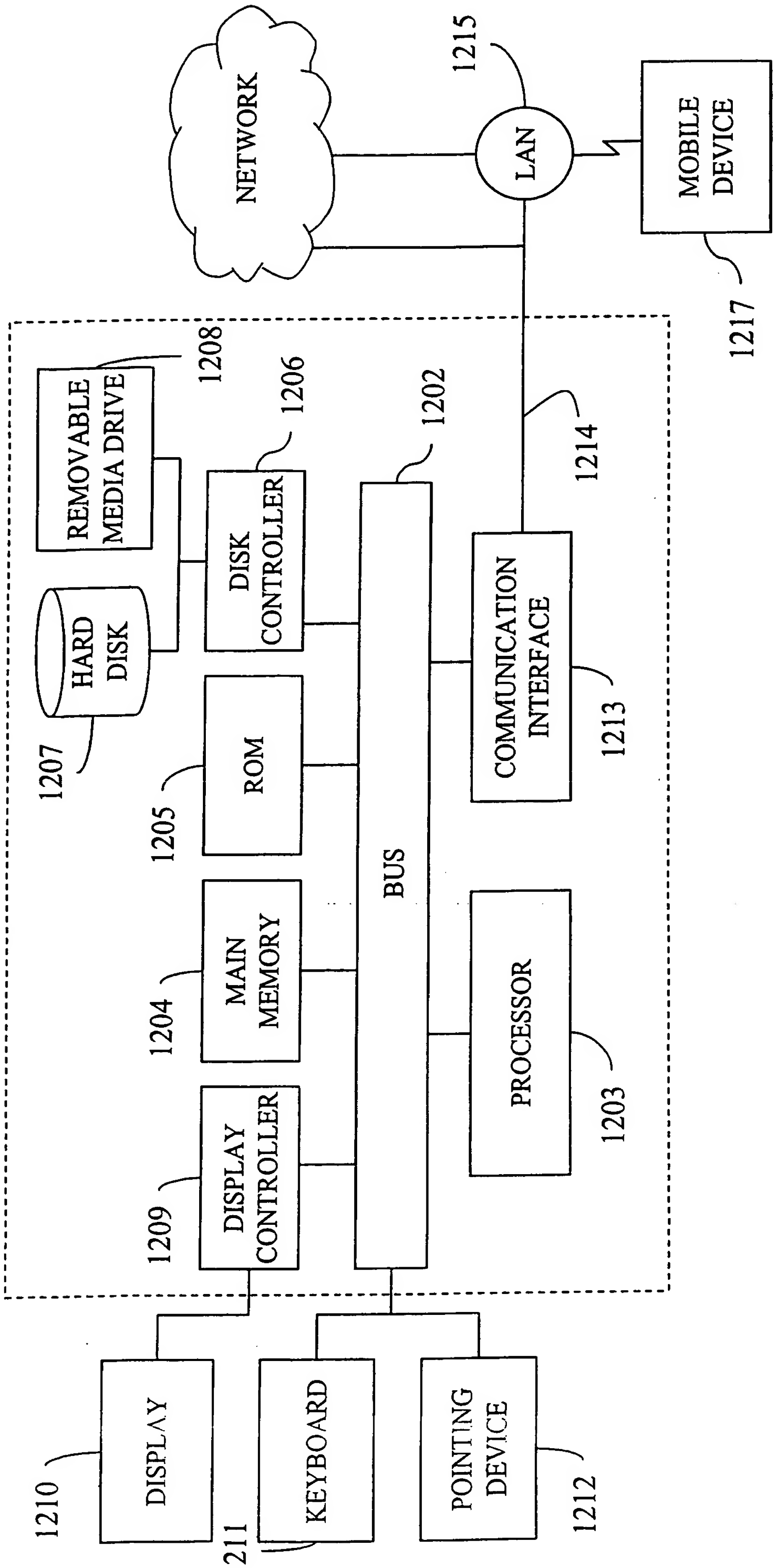

NETWORK
LAN
1215
MOBILE DEVICE
1217
REMOVABLE MEDIA DRIVE
1208
HARD DISK
1207
DISK CONTROLLER
1206
1202
1214
COMMUNICATION INTERFACE
1213
ROM
1205
BUS
MAIN MEMORY
1204
PROCESSOR
1203
DISPLAY CONTROLLER
1209
DISPLAY
1210
KEYBOARD
1211
POINTING DEVICE
1212

FIGURE 68